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ENERGY EFFICIENCY/RENEWABLE ENERGY IMPACT IN THE TEXAS EMISSIONS REDUCTION PLAN (TERP)

VOLUME II—TECHNICAL REPORT

Annual Report to the
Texas Commission on Environmental Quality
January 2009-December 2009

TCEQ

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December 2010

ENERGY SYSTEMS LABORATORY

Texas Engineering Experiment Station
Texas A&M University System

ENERGY SYSTEMS LABORATORY
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3581 TAMU
College Station, Texas 77843-3581

December 2, 2010

Chairman Bryan W. Shaw
Texas Council on Environmental Quality
P. O. Box 13087
Austin, TX 78711-3087

Dear Chairman Shaw:

The Energy Systems Laboratory (Laboratory) at the Texas Engineering Experiment Station of the Texas A&M University System is pleased to provide its eighth annual report, “Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP),” as required under Texas Health and Safety Code Ann. § 388.003 (e), Vernon Supp. 2002 (Senate Bill 5, 77R as amended 78 R & 78S).

The Laboratory is required to annually report the energy savings from statewide adoption of the Texas Building Energy Performance Standards in Senate Bill 5 (SB 5), as amended, and the relative impact of proposed local energy code amendments in the Texas non-attainment and near-non-attainment counties as part of the Texas Emissions Reduction Plan (TERP).

Please contact me at (979) 845-1280 should you or any of the TCEQ staff have any questions concerning this report or any of the work presently being done to quantify emissions reduction from energy efficiency and renewable energy measures as a result of the TERP implementation.

Sincerely,

David E. Claridge

David E. Claridge, Ph.D., P.E.
Director

Enclosure

cc: Commissioner Carlos Rubinstein
Commissioner Buddy Garcia
Executive Director Mark Vickery

Disclaimer

VOLUME II – TECHNICAL REPORT

Energy Efficiency / Renewable Energy Impact In The Texas Emissions Reduction Plan

1 Executive Summary

The Energy Systems Laboratory (Laboratory), at the Texas Engineering Experiment Station of the Texas A&M University System, in fulfillment of its responsibilities under Texas Health and Safety Code Ann. § 388.003 (e), Vernon Supp. 2002, submits its eighth annual report, Energy Efficiency/Renewable Energy (EE/RE) Impact in the Texas Emissions Reduction Plan to the Texas Commission on Environmental Quality.

The report is organized in three volumes.

- Volume I – Summary Report – provides an executive summary and overview;
- Volume II – Technical Report – provides a detailed report of activities, methodologies and findings;
- Volume III – Technical Appendix – contains detailed data from simulations for each of the counties included in the analysis.

Accomplishments:

1. Energy Code Amendments

The Laboratory was requested by several Council of Governments (COGs) and municipalities to analyze the stringency of several proposed residential and commercial energy code amendments, including: the 2003 and 2006 IECC and the ASHRAE Standards 90.1-2001 and 90.1-2004. Results of the analysis are included in this Volume II—Technical Report.

2. Technical Assistance

The Laboratory provided technical assistance to the TCEQ, PUCT, SECO, ERCOT, and several political subdivisions, as well as Stakeholders participating in improving the compliance of the Texas Building Energy Performance Standards (TBEPS). The Laboratory also worked closely with the TCEQ to refine the integrated NOx emissions reduction calculation procedures that provide the TCEQ with a standardized, creditable NOx emissions reduction from energy efficiency and renewable energy (EE/RE) programs, which are acceptable to the US EPA. These activities have improved the accuracy of the creditable NOx emissions reduction from EE/RE initiatives contained in the TERP and have assisted the TCEQ, local governments, and the building industry with effective, standardized implementation and reporting.

3. NOx Emissions Reduction

Under the TERP legislation, the Laboratory must determine the energy savings from energy code adoption and, when applicable, from more stringent local codes or above-code performance ratings, and must report these reductions annually to the TCEQ.

Figure 1 shows the cumulative NOx emissions reduction through 2020 for the electricity and natural gas savings from the various EE/RE programs.

In 2009, the cumulative annual NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 1,189 tons-NOx/year (7.8% of the total NOx savings); savings from retrofits to Federal buildings is 193 tons-NOx/year (1.3%), savings from furnace pilot light retrofits is 117 tons-NOx/year (0.8%); savings from the PUC's Senate Bill 5 and Senate Bill 7 programs is 1,637 tons-NOx/year (10.7%); savings from SECO's Senate Bill 5 program is 349 tons-NOx/year (2.3%); electricity savings from green power purchases (wind) is 10,957 tons-NOx/year (71.5%); savings from residential air conditioner retrofits is 884 tons-NOx/year (5.8%). The total NOx emissions reduction from all programs is 15,327 tons-NOx/year.

In 2009, the OSD NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 6.56 tons-NOx/day (16.1%); savings from retrofits to Federal buildings is 0.51 tons-NOx/day (1.3%), savings from furnace pilot light retrofits is 0.32 tons-NOx/day (0.8%); savings from the PUC's Senate Bill 5 and Senate Bill 7 programs is 4.39 tons-NOx/day (10.8%); savings from SECO's Senate Bill 5 program is 0.95 tons-NOx/day (2.3%); electricity savings from green power purchases (wind) are 21.79 tons-NOx/day (53.5%); savings from residential air conditioner retrofits are 6.19 tons-NOx/day (15.2%). The total NOx emissions reduction from all programs is 40.71 tons-NOx/day.

By 2013, the cumulative NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 1,540 tons-NOx/year (8.0% of the total NOx savings); savings from retrofits to Federal buildings will be 308 tons-NOx/year (1.6%); savings from furnace pilot light retrofits will be 117 tons-NOx/year (0.6%); savings from the PUC's Senate Bill 5 and Senate Bill 7 programs will be 2,336 tons-NOx/year (12.1%); savings from SECO's Senate Bill 5 program will be 373 tons-NOx/year (1.9%); electricity savings from green power purchases (wind) will be 13,065 tons-NOx/year (67.6%); savings from residential air conditioner retrofits will be 1,575 tons-NOx/year (8.2%). The total NOx emissions reduction from all programs will be 19,314 tons-NOx/year.

By 2013, the OSD NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 8.72 tons-NOx/day (16.1%); savings from retrofits to Federal buildings will be 0.81 tons-NOx/day (1.5%); savings from furnace pilot light retrofits will be 0.32 tons-NOx/day (0.6%); savings from the PUC's Senate Bill 5 and Senate Bill 7 programs will be 6.28 tons-NOx/day (11.6%); savings from SECO's Senate Bill 5 program will be 1.01 tons-NOx/day (1.9%); electricity savings from green power purchases (wind) will be 25.99 tons-NOx/day (48.0%); savings from residential air conditioner retrofits will be 11.03 tons-NOx/day (20.4%). The total NOx emissions reduction from all programs will be 54.16 tons-NOx/day.

4. Technology Transfer

The Laboratory, along with the TCEQ, is host to the annual Clean Air Through Energy Efficiency (CATEE) conference, which is attended by top experts and policy makers in Texas and from around the country. At the conference, the latest educational programs and technology is presented and discussed, including efforts by the Laboratory, and others, to reduce air pollution in Texas through energy efficiency and renewable energy. These efforts have produced significant success in bringing EE/RE closer to US EPA acceptance in the Texas SIP. The Laboratory will continue to provide superior technology to the State of Texas through such efforts with the TCEQ and the US EPA.

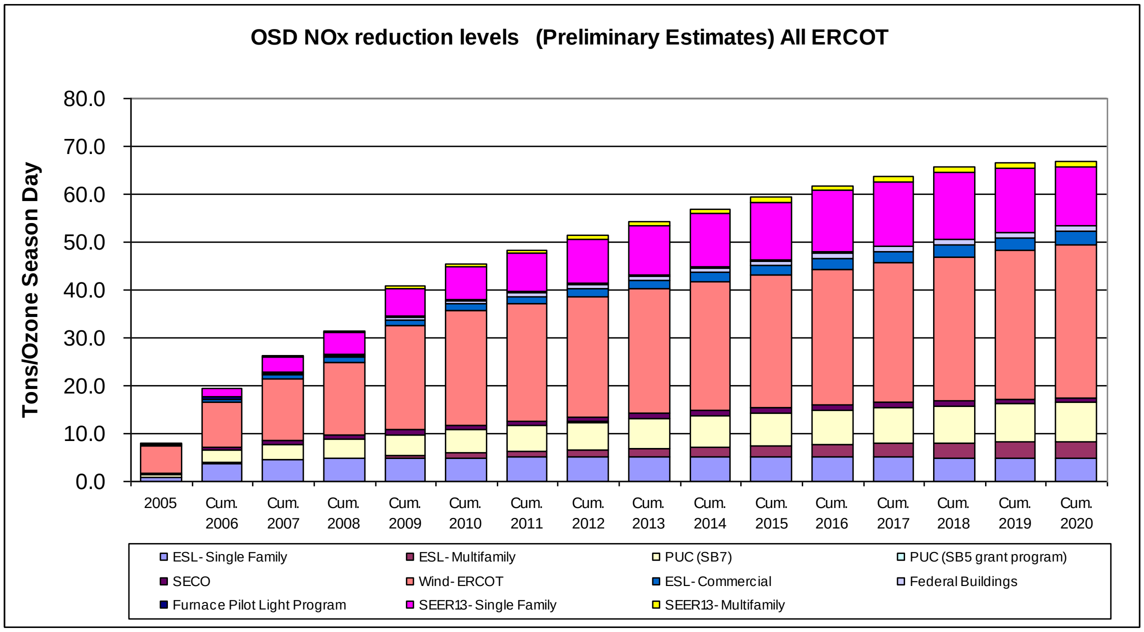

Figure 1: OSD NOx Emissions Reduction Projections through 2020

To accelerate the transfer of technology developed as part of the TERP, the Laboratory has also made presentations at national, state and local meetings and conferences, which includes the publication of peer-reviewed papers. The Laboratory will continue to provide technical assistance to the TCEQ, counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering emissions and improving the air quality for all Texans.

These efforts have been recognized nationally by the US EPA. In 2007, the Laboratory was awarded a National Center of Excellence on Displaced Emissions Reduction (CEDER) by the US EPA so that these accomplishments could be rapidly disseminated to other states for their use. The benefits of CEDER include: reducing the financial, technical, and administrative costs of determining the emissions reduction from EE/RE measures; continuing to accelerate implementation of EE/RE strategies as a viable clean air effort in Texas and other states; helping other states better identify and prioritize cost-effective clean air strategies from EE/RE, and communicating the results of quantification efforts through case-studies and a clearinghouse of information.

The Energy Systems Laboratory provides the seventh annual report, Energy Efficiency/Renewable Energy (EE/RE) Impact in the Texas Emissions Reduction Plan (TERP), to the Texas Commission on Environmental Quality (TCEQ) in fulfillment of its responsibilities under Texas Health and Safety Code Ann. § 388.003 (e), Vernon Supp. 2002.

If any questions arise, please contact us by phone at 979-862-2804, or by email at terpinfo@tees.tamus.edu.

2 Acknowledgements

This work has been completed as a fulfillment of the requirements in Texas Health Code, Senate Bill 5, Section 388.003, and through Senate Bill 20, House Bill 2481 and House Bill 2129, which requires the Laboratory to assist TCEQ in quantifying emissions reductions credits from energy efficiency and renewable energy programs, through a contract with the Texas Environmental Research Consortium (TERC). Similarly, selected Code training workshops were funded by the US DOE through the Texas State Energy Conservation Office (SECO). Partial funding on the Texas Climate Vision project, a joint project with the City of Austin was also provided by the US DOE through SECO.

The authors are also grateful for the timely input provided by the following individuals, and agencies: Mr. Art Diem, US EPA, for providing the eGRID database and Vincent Meiller and Robert Gifford.

Numerous additional individuals at the Laboratory contributed significantly to this report, including: Kyle Marshall, Robert Stackhouse, Jason Cordes, Stephen O'Neal, and Christina Riddle.

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3 Overview

The Energy Systems Laboratory (Laboratory), at the Texas Engineering Experiment Station of the Texas A&M University System, is pleased to provide our eighth annual report, Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP), to the Texas Commission on Environmental Quality (TCEQ) in fulfillment of its responsibilities under Texas Health and Safety Code Ann. § 388.003 (e), Vernon Supp. 2002. This annual report:

- Provides an estimate of the energy savings and NOx reductions from energy code compliance in new residential construction in all ERCOT counties;
- Provides an estimate of the standardized, cumulative, integrated energy savings and NOx reductions from the TERP programs implemented by the Laboratory, SECO, the PUC and ERCOT in all ERCOT Texas;
- Describes the technology developed to enable the TCEQ to substantiate energy and emissions reduction credits from energy efficiency and renewable energy initiatives (EE/RE) to the U.S. Environmental Protection Agency (US EPA), including the development of a web-based emissions reduction calculator; and
- Outlines progress in advancing EE/RE strategies for credit in the Texas State Implementation Plan (SIP).

The report is organized in three volumes.

Volume I – Summary Report – provides an executive summary and overview;
Volume II – Technical Report – provides a detailed report of activities, methodologies and findings;
Volume III – Technical Appendix – contains detailed data from code-compliant energy simulations for all ERCOT counties in Texas included in the analysis.

3.1 Legislative Background

The TERP was established in 2001 by the 77th Legislature through the enactment of Senate Bill 5 to:

- Ensure that Texas air meets the Federal Clean Air Act requirements (Section 707, Title 42, United States Code); and
- Reduce NOx emissions in non-attainment and near-non-attainment counties through mandatory and voluntary programs, including the implementation of energy efficiency and renewable energy programs (EE/RE).

To achieve the clean air and emissions reduction goals of the TERP, Senate Bill 5 created a number of EE/RE programs for credit in the SIP:

- Adopts statewide Texas Building Energy Performance Standards (TBEPS) as the building energy code for all residential and commercial buildings;
- Provides that a municipality or county may request the Laboratory to determine the energy impact of proposed energy code changes;
- Provides for an annual evaluation by the Public Utility Commission of Texas (PUCT), in cooperation with the Laboratory, of the emissions reduction of energy demand, peak electric loads and the associated air contaminant reductions from utility-sponsored programs established under Senate Bill 5 and utility-sponsored programs established under the electric utility restructuring act (Section 39.905 Utilities Code);
- Establishes a 5% per year electricity reduction goal each year for facilities of political subdivisions in non-attainment and near-non-attainment counties from 2002 through 2008; and
- Requires the Laboratory to report annually to the TCEQ the energy savings (and resultant emissions reduction) from implementation of building energy codes and to identify the municipalities and counties whose codes are more or less stringent than the un-amended code.

The 78th Legislature (2003), through HB 1365 and HB 3235, amended TERP to enhance its effectiveness with additional energy efficiency initiatives, and includes:

- Requires the TCEQ to conduct outreach to non-attainment and near-non-attainment counties on the benefits of implementing energy efficiency measures as a way to meet the air quality goals under the federal Clean Air Act;
- Requires the TCEQ develop a methodology for computing emissions reduction from energy efficiency initiatives;
- Authorized a voluntary Energy-Efficient Building Program at the General Land Office (GLO), in consultation with the Laboratory, for the accreditation of buildings that exceed the state energy code requirements by 15% or more;
- Authorizes municipalities to adopt an optional, alternate energy code compliance mechanism through the use of accredited energy efficiency programs determined to be code-compliant by the Laboratory, as well as the US EPA's Energy Star New Homes program; and
- Requires the Laboratory to develop and administer a statewide training program for municipal building inspectors seeking to become code-certified inspectors for enforcement of energy codes.

The 79th Legislature (2005), through SB 20, HB 2481 and HB 2129, amended Senate Bill 5 to enhance its effectiveness by adding the following additional energy efficiency initiatives:

- Requires 5,880 MW of generating capacity from renewable energy technologies by 2015;
- Includes 500 MW from non-wind renewables;
- Requires the PUCT to establish a target of 10,000 megawatts of installed renewable capacity by 2025;
- Requires the TCEQ to develop methodology for computing emissions reduction from renewable energy initiatives and the associated credits;
- Requires the Laboratory to assist the TCEQ in quantifying emissions reduction credits from energy efficiency and renewable energy programs;
- Requires the Texas Environmental Research Consortium (TERC) to contract with the Laboratory to develop and annually calculate creditable emissions reduction from wind and other renewable energy resources for the state's SIP; and
- Requires the Laboratory to develop at least three alternative methods for achieving a 15 % greater potential energy savings in residential, commercial and industrial construction.

The 80th Legislature (2007), through SB 12, and HB 3693 amended Senate Bill 5 to enhance its effectiveness by adding the following additional energy efficiency initiatives:

- Requires the Laboratory to provide written recommendations to the State Energy Conservation Office (SECO) about whether or not the energy efficiency provisions of latest published edition of the International Residential Code (IRC) or the International Energy Conservation Code (IECC) are equivalent to or better than the energy efficiency and air quality achievable under the editions adopted under the 2001 IRC/IECC. The Laboratory shall make its recommendations no later than six months after publication of new editions at the end of each three-year code development cycle of the International Residential Code and the International Energy Conservation Code.
- Requires the Laboratory to consider comments made by persons who have an interest in the adoption of the energy codes in the recommendations made to SECO.
- Requires the Laboratory to develop a standardized report format to be used by providers of home energy ratings, including different report formats for rating newly constructed residences from those for existing residences. The form must be designed to give potential buyers information on a structure's energy performance, including: insulation; types of windows; heating and cooling equipment; water heating equipment; additional energy conserving features, if any; results of performance measurements of building tightness and forced air distribution; and an overall rating of probable energy efficiency relative to the minimum requirements of the International Energy Conservation Code or the energy efficiency chapter of the International Residential Code, as appropriate.
- Encourages the Laboratory to cooperate with an industry organization or trade association to: develop guidelines for home energy ratings; provide training for individuals performing home energy ratings and providers of home energy ratings; and provide a registry of completed ratings for newly constructed residences and residential improvement projects for the purpose of

computing the energy savings and emissions reduction benefits of the home energy ratings program.
- Requires the Laboratory to include information on the benefits attained from this program in an annual report to the commission.

3.2 Laboratory Funding for the TERP

The Laboratory received $182,000 in FY 2002; $285,000 in FY 2003; $950,421 in FY 2004; $952,019 each year for FY 2005 through FY 2009. The Laboratory has also supplemented these funds with competitively awarded Federal and State grants to provide the needed statewide training for the new mandatory energy codes and to provide technical assistance to cities and counties in helping them implement adoption of the legislated energy efficiency codes. In addition, the ESL received an award from the US EPA in the spring of 2007 to establish a Center of Excellence for the Determination of Emissions Reduction (CEDER) which has helped to enhance the EE/RE emissions calculations.

3.3 Accomplishments since January 2009

Since January of 2009, the Laboratory has accomplished the following:
- Calculated energy and resultant NOx reductions from implementation of the Texas Building Energy Performance Standards (IECC/IRC codes) to new residential and commercial construction for all non-attainment and near-non-attainment counties;
- Enhanced the Laboratory’s IECC/IRC Code-Traceable Test Suite for determining emissions reduction due to code and above-code programs;
- Enhanced the IC3 calculator, which is energy code compliance software based on the Texas Building Energy Performance Standards by adding 3-story, multi-family model in the calculator and extending the code to include Houston Amendments and 2009 IECC;
- Continued development and testing of key procedures for validating simulations of building energy performance;
- Provided energy code training workshops, including: residential, commercial IECC/IRC energy code training sessions, code-compliant software sessions throughout the State of Texas;
- Maintained and updated the Laboratory’s Texas Emissions Reduction Plan (TERP) website;
- Maintained a builder’s residential energy code Self-Certification Form (Ver.1.3) for use by builders outside municipalities;
- Analyzed the stringency of several residential and commercial energy codes, including the 2009 IECC, 2009 IRC and ASHRAE Standard 90.1 2007;
- Hosted the Clean Air Through Energy Efficiency (CATEE) Conference in October 2009, in Houston, Texas. Conference sessions included key talks by the TCEQ, EPA, DOE and the Laboratory about quantifying emissions reduction from EE/RE opportunities and guidance on key energy efficiency and renewable energy topics;
- Provided technical assistance to the TCEQ regarding specific issues, including:
    - Enhancement of the standardized, integrated NOx emissions reduction reporting procedures to the TCEQ for EE/RE projects;
    - Enhancement of the procedures for weather normalizing NOx emissions reduction from renewable projects;
- Enhanced the web-based emissions reduction calculator, including:
    - Continued the enhancement of the new computer architecture to allow for synchronous calculations, user accounts, and code-compliance;
- Developed 15% above code recommendations for residential buildings;
- Continued the development of verification procedures, including:
    - Worked toward the code compliance tools for commercial buildings, retail and school buildings.

3.4 Technology Transfer

To accelerate the transfer of technology developed as part of the TERP program, the Laboratory:

- Delivered “Statewide Air Emissions Calculations from Wind and Other Renewables,” to the Texas Commission on Environmental Quality in August 2009.
- Updated previously developed degradation analysis to determine if degradation could be observed in the measured power from Texas wind farms.
- Updated previously developed database of other renewable projects in Texas, including: solar photovoltaic, geothermal, hydroelectric, and Landfill Gas-fired Power Plants.
- Applied previously developed estimation techniques for hourly solar radiation from limited data sets.
- Worked with the EPA and TCEQ and developed a new version of eGRID for all ERCOT counties in Texas.
- Along with the TCEQ and the US EPA, is host to the annual Clean Air Through Energy Efficiency (CATEE) Conference attended by top Texas experts and policy makers and national experts.
- Continued the National Center of Excellence on Displaced Emissions Reduction (CEDER) by the US EPA. The benefits of CEDER include:
    - reducing the financial, technical, and administrative costs of determining the emissions reduction from EE/RE measures;
    - continuing to accelerate implementation of EE/RE strategies as a viable clean air effort in Texas and other states;
    - helping other states identify and prioritize cost-effective clean air strategies from EE/RE, and;
    - communicating the results of quantification efforts through case-studies and a clearinghouse of information.

In addition to the tasks listed above, the Laboratory delivered presentations regarding the TERP related work, including:

- Presentation to EPA Sustainable Skylines, Dallas, Texas, March 2009
- Presentation to the Texas Senate and Energy Efficiency Committee, Austin, Texas, March 2009
- Presentation to IBPSA, Glasgow, Scotland, July 2009
- Presentation to CATEE conference, Houston, Texas, October 2009

Presentation of six papers at the International Conference for Enhanced Building Operation, Austin, Texas, November 2009, including:

- Marshall, K.; Moss, M.; Malhotra, M.; Liu, B.; Culp, C.; Haberl, J.; Herbert, C. 2009. “AIM: A Home-Owner Usable Energy Calculator for Existing Residential Homes,” *Proceedings of the 9th International Conference for Enhanced Building Operation*, Austin, Texas
- Masuda, H.; Ji, J.; Baltazar, J.C. 2009. “Use of First Law energy Balance as a Screening Tool for Building Energy Use Data: Experiences on the Inclusion of Outside Air Enthalpy Variable,” *Proceedings of the 9th International Conference for Enhanced Building Operation*, Austin, Texas
- Christman, K.D.; Haberl, J.; Claridge, D. 2009. “Analysis of Energy Recovery Ventilator Savings for Texas Buildings,” *Proceedings of the 9th International Conference for Enhanced Building Operation*, Austin, Texas
- Mukhopadhyay, J.; Liu, Z.; Malhotra, M.; Kota, S.; Blake, S.; Haberl, J.; Culp, C.; Yazdani, B. 2009. “Recommendations for 15% Above-Code Energy Efficiency Measures on Implementing Houston Amendments to Single-Family Residential Buildings in Houston, Texas,” *Proceedings of the 9th International Conference for Enhanced Building Operation*, Austin, Texas
- Mukhopadhyay, J.; Liu, Z.; Malhotra, M.; Kota, S.; Blake, S.; Haberl, J.; Culp, C.; Yazdani, B. 2009. “Recommendations for 15% Above-Code Energy Efficiency Measures on Implementing Houston Amendments to Multifamily Residential Buildings in Houston, Texas,” *Proceedings of the 9th International Conference for Enhanced Building Operation*, Austin, Texas
- Kim, S.; Haberl, J. 2009. “Development of DOE-2 Based Simulation for the Code-Compliant Commercial Construction Based on the ASHRAE Standard 90.1,” *Proceedings of the 9th International Conference for Enhanced Building Operation*, Austin, Texas

The Laboratory has and will continue to provide leading-edge technical assistance to the TCEQ, counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering emissions and improving the air quality for all Texans. The Laboratory will continue to provide superior technology to the State of Texas through efforts with the TCEQ and US EPA. The efforts taken by the Laboratory have produced significant success in bringing EE/RE closer to US EPA acceptance in the SIP. These activities were designed to more accurately calculate the creditable NOx emissions reduction from EE/RE initiatives contained in the TERP and to assist the TCEQ, local governments, and the building industry with standardized, effective implementation and reporting.

3.5 Energy and NOx Reductions from New Residential and Commercial Construction, including furnace pilot light savings and residential air conditioner retrofits

State adoption of the energy efficiency provisions of the International Residential Code (IRC) and International Energy Conservation Code (IECC) became effective September 1, 2001. The Laboratory has developed and delivered training to assist municipal inspectors to become certified energy inspectors. The Laboratory also supported code officials with guidance on interpretations as needed. This effort, based on a requirement of HB 3235, 78th Texas Legislature, supports a more uniform interpretation and application of energy codes throughout the state. In general, the State is experiencing a true market transformation from low energy efficiency products to high energy efficiency products. These include: low solar heat gain windows, higher efficiency appliances, high efficiency air conditioners and heat pumps, increased insulation, lower thermal loss ducts and in-builder participation in "above-code" code programs such as Energy Star New Homes, which previously had no state baseline and almost no participation.

In 2009, the annual electricity savings[1] from code-compliant residential and commercial construction is calculated to be 1,688,687 MWh/year (6.6% of the total electricity savings), savings from furnace pilot light retrofits is 2,548,904 MBtu/year, and savings from residential air conditioner retrofits[2] is 1,283,931 MWh/year (5.0%).

In 2009, the OSD electricity savings from code-compliant residential and commercial construction is calculated to be 9,510 MWh/day (14.3%), savings from furnace pilot light retrofits is 6,983 MBtu/day, and savings from residential air conditioner retrofits are 9,106 MWh/day (13.7%).

By 2013, the annual electricity savings from code-compliant residential and commercial construction is calculated to be 2,176,034 MWh/year (6.8% of the total electricity savings), savings from furnace pilot light retrofits will remain at 2,548,904 MBtu/year, and savings from residential air conditioner retrofits[3] will be 2,286,233 MWh/year (7.1%).

By 2013, the OSD electricity savings from code-compliant residential and commercial construction is calculated to be 12,566 MWh/day (14.4%), savings from furnace pilot light retrofits will remain at 6,983 MBtu/day, and savings from residential air conditioner retrofits will be 16,216 MWh/day (18.6%).

In 2008, the annual NOx emissions reduction[4] from code-compliant residential and commercial construction is calculated to be 1,090 tons-NOx/year (7.8% of the total NOx savings), savings from furnace pilot light retrofits is 117 tons-NOx/year (0.8%), and savings from residential air conditioner retrofits is 884 tons-NOx/year (5.8%).

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[1] This includes the savings from 2001 through 2008.

[2] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

[3] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

[4] These NOx emissions reduction were calculated with the US EPA's 2007 eGRID for annual (25% capacity factor) and Ozone Season Day OSD.

In 2008, the OSD NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 6.56 tons-NOx/day (16.1%), savings from furnace pilot light retrofits is 0.32 tons-NOx/day (0.8%), and savings from residential air conditioner retrofits are 6.19 tons-NOx/day (15.2%).

By 2013, the NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 1,541 tons-NOx/year (8.0% of the total NOx savings), savings from furnace pilot light retrofits will be 117 tons-NOx/year (0.6%), and savings from residential air conditioner retrofits will be 1,574 tons-NOx/year (8.1%).

By 2013, the OSD NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 8.72 tons-NOx/day (16.1%), savings from furnace pilot light retrofits will be 0.32 tons-NOx/day (0.6 %), and savings from residential air conditioner retrofits will be 11.03 tons-NOx/day (20.4%).

3.6 Integrated NOx Emissions Reductions Reporting Across State Agencies

Beginning in 2005, the Laboratory worked with the TCEQ to develop a standardized, integrated NOx emissions reduction across state agencies implementing EE/RE programs so that the results can be evaluated consistently. As required by the legislation, the TCEQ receives reports: from the Laboratory on savings from code compliance and renewables; from the Laboratory, in cooperation with the Electric Reliability Council of Texas (ERCOT), on the savings from electricity generated from wind power; from the Public Utilities Commission of Texas (PUCT) on the impacts of the utility-administered programs designed to meet the mandated energy efficiency goals of SB7 and SB5; and from the State Energy Conservation Office (SECO) on the impacts of energy conservation in state agencies and political subdivisions.

The total annual and OSD electricity savings for all the different programs in the integrated format was calculated using the adjustment factors for 2001 through 2020. NOx emissions reduction from the electricity and natural gas savings for the annual and OSD for all the programs in the integrated format were calculated.

In 2009, the cumulative annual electricity savings[5] from code-compliant residential and commercial construction is calculated to be 1,688,687 MWh/year (6.6% of the total electricity savings), savings from retrofits to Federal buildings is 251,708 MWh/year (1.0%), savings from furnace pilot light retrofits is 2,548,904 MMBtu/year (2.9%), which is equivalent to 746,822 MWh/year, savings from the PUC’s Senate Bill 5 and Senate Bill 7 programs is 2,347,661 MWh/year (9.2%), savings from SECO’s Senate Bill 5 program is 457,921 MWh/year (1.8%), electricity savings from green power purchases (wind) is 18,808,351 MWh/year (73.5%), and savings from residential air conditioner retrofits[6] is 1,283,931 MWh/year (5.0%). The total savings from all programs is 25,585,081 MWh/year.

In 2009, the cumulative OSD electricity savings from code-compliant residential and commercial construction is calculated to be 9,510 MWh/day (14.3%), savings from retrofits to Federal buildings is 690 MWh/day (1.0%), savings from furnace pilot light retrofits is 6,983 MMBtu/day (3.1%), which is equivalent to 2,046 MWh/day, savings from the PUC’s Senate Bill 5 and Senate Bill 7 programs is 6,432 MWh/day (9.7%), savings from SECO’s Senate Bill 5 program is 1,255 MWh/day (1.9%), electricity savings from green power purchases (wind) are 37,261 MWh/day (56.2%), and savings from residential air conditioner retrofits are 9,106 MWh/day (13.7%). The total savings from all programs is 66,300 MWh/day (64,254 MWh/day and 6,983 MMBtu/day), which would be a 2,763 MW average hourly load reduction during the OSD period.

By 2013, the cumulative annual electricity savings from code-compliant residential and commercial construction is calculated to be 2,176,034 MWh/year (6.8% of the total electricity savings), savings from

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[5] This includes the savings from 2001 through 2009.
[6] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

retrofits to Federal buildings will be 402,732 MWh/year (1.3%), savings from furnace pilot light retrofits will remain at 2,548,904 MMBtu/year (2.3%), which is equivalent to 746,822 MWh/year, savings from the PUC's Senate Bill 5 and Senate Bill 7 programs will be 3,451,975 MWh/year (10.8%), savings from SECO's Senate Bill 5 program will be 489,440 MWh/year (1.5%), electricity savings from green power purchases (wind) will be 22,426,692 MWh/year (70.1%), and savings from residential air conditioner retrofits[7] will be 2,286,233 MWh/year (7.1%). The total savings from all programs will be 31,979,928 MWh/year.

By 2013, the cumulative OSD electricity savings from code-compliant residential and commercial construction is calculated to be 12,566 MWh/day (14.4%), savings from retrofits to Federal buildings will be 1,103 MWh/day (1.3%), savings from furnace pilot light retrofits will remain at 6,983 MMBtu/day (2.3%), which is equivalent to 2,046 MWh/day, savings from the PUC's Senate Bill 5 and Senate Bill 7 programs will be 9,458 MWh/day (10.9%), savings from SECO's Senate Bill 5 program will be 1,341 MWh/day (1.5%), electricity savings from green power purchases (wind) will be 44,429 MWh/day (51.0%), and savings from residential air conditioner retrofits will be 16,216 MWh/day (18.6%). The total savings from all programs will be 87,159 MWh/day (85,113 MWh/day and 6,983 MMBtu/day), which would be a 3,632 MW average hourly load reduction during the OSD period.

In 2009, the cumulative annual NOx emissions reduction[8] from code-compliant residential and commercial construction is calculated to be 1,090 tons-NOx/year (7.8% of the total NOx savings), savings from retrofits to Federal buildings is 193 tons-NOx/year (1.3%), savings from furnace pilot light retrofits is 117 tons-NOx/year (0.8%), savings from the PUC's Senate Bill 5 and Senate Bill 7 programs is 1,638 tons-NOx/year (10.7%), savings from SECO's Senate Bill 5 program is 349 tons-NOx/year (2.3%), electricity savings from green power purchases (wind) is 10,957 tons-NOx/year (71.5%), and savings from residential air conditioner retrofits is 884 tons-NOx/year (5.8%). The total NOx emissions reduction from all programs is 15,328 tons-NOx/year.

In 2009, the cumulative OSD NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 6.56 tons-NOx/day (16.1%), savings from retrofits to Federal buildings is 0.51 tons-NOx/day (1.3%), savings from furnace pilot light retrofits is 0.32 tons-NOx/day (0.8%), savings from the PUC's Senate Bill 5 and Senate Bill 7 programs is 4.39 tons-NOx/day (10.8%) , savings from SECO's Senate Bill 5 program is 0.95 tons-NOx/day (2.3%), electricity savings from green power purchases (wind) are 21.79 tons-NOx/day (53.5%), and savings from residential air conditioner retrofits are 6.19 tons-NOx/day (15.2%). The total NOx emissions reduction from all programs is 40.71 tons-NOx/day.

By 2013, the cumulative NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 1,541 tons-NOx/year (8.0% of the total NOx savings), savings from retrofits to Federal buildings will be 308 tons-NOx/year (1.6%), savings from furnace pilot light retrofits will be 117 tons-NOx/year (0.6%), savings from the PUC's Senate Bill 5 and Senate Bill 7 programs will be 2,355 tons-NOx/year (12.1%), savings from SECO's Senate Bill 5 program will be 373 tons-NOx/year (1.9%), electricity savings from green power purchases (wind) will be 13,065 tons-NOx/year (67.6%), and savings from residential air conditioner retrofits will be 1,574 tons-NOx/year (8.1%). The total NOx emissions reduction from all programs will be 19,313 tons-NOx/year.

By 2013, the cumulative OSD NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 8.72 tons-NOx/day (16.1%), savings from retrofits to Federal buildings will be 0.81 tons-NOx/day (1.5%), savings from furnace pilot light retrofits will be 0.32 tons-NOx/day (0.6%), savings from the PUC's Senate Bill 5 and Senate Bill 7 programs will be 6.28 tons-NOx/day (11.6%), savings from SECO's Senate Bill 5 program will be 1.01 tons-NOx/day (1.9%), electricity savings from green power purchases (wind) will be 25.99 tons-NOx/day (48.0%), and savings from residential air conditioner retrofits will be 11.03 tons-NOx/day (20.4%). The total NOx emissions reduction from all programs will be 54.16 tons-NOx/day.

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[7] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

[8] These NOx emissions reduction were calculated with the US EPA's 2007 eGRID for annual (25% capacity factor) and Ozone Season Day OSD.

Figure 2 shows the NOx emissions reduction through 2020 for the electricity and natural gas savings from all TERP programs reporting to the TCEQ. Table 1 provides the details regarding the annual degradation, transmission and distribution losses, discount factors and growth factors that were used in the analysis[9]. Additional details of the analysis are reported in Volume III of this report.

Table 1: Adjustment Factors used for the Calculation of the Annual and OSD NOx Savings for the Different Programs

	ESL-Single Family[16]	ESL-Multifamily[16]	ESL-Commercial[16]	Federal Buildings[15]	Furnace Pilot Light Program[15]	PUC (SB7)[15]	PUC (SB5 Grant Program)[15]	SECO[15]	Wind-ERCOT[8]	SEER13 Single Family	SEER13 Multifamily
Annual Degradation Factor [11]	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	0.00%	5.00%	5.00%
T&D Loss [9]	7.00%	7.00%	7.00%	7.00%	0.00%	7.00%	7.00%	7.00%	0.00%	7.00%	7.00%
Initial Discount Factor [12]	20.00%	20.00%	20.00%	20.00%	20.00%	25.00%	25.00%	60.00%	25.00%	20.00%	20.00%
Growth Factor	3.25%	1.54%	3.25%	0.00%	0.00%	0.00%	0.00%	0.00%	Actual Rates	N.A.	N.A.
Weather Normalized	Yes	Yes	Yes	No	No	No	No	No	See note 7	Yes	Yes

[9] These factors were determined by TCEQ.

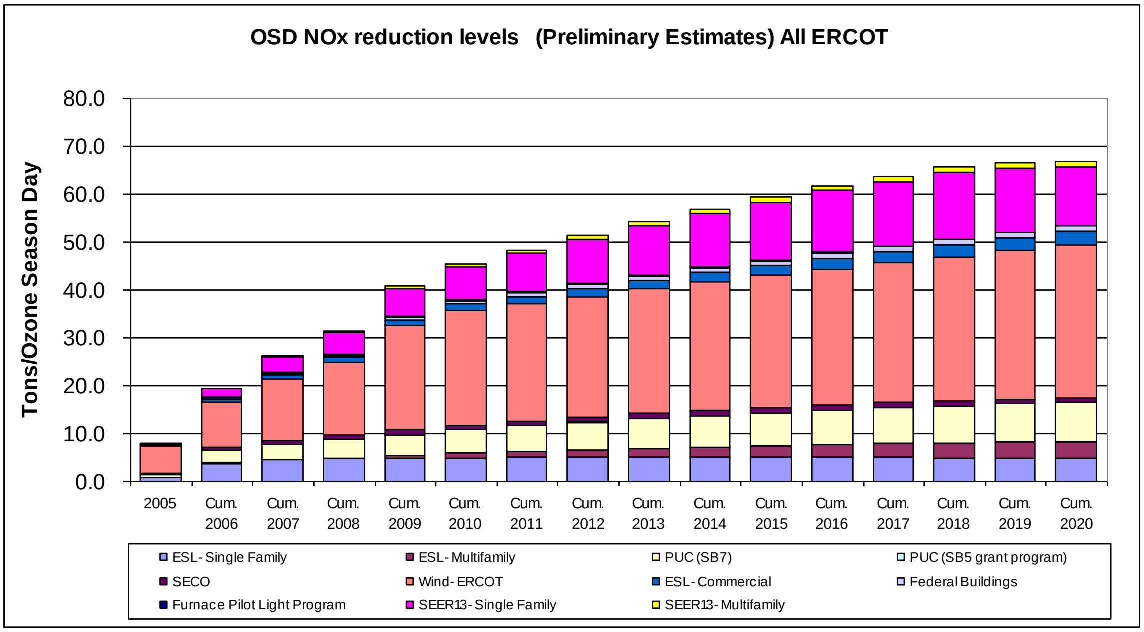


Figure 2: Cumulative OSD NOx Emissions Reduction Projections through 2020

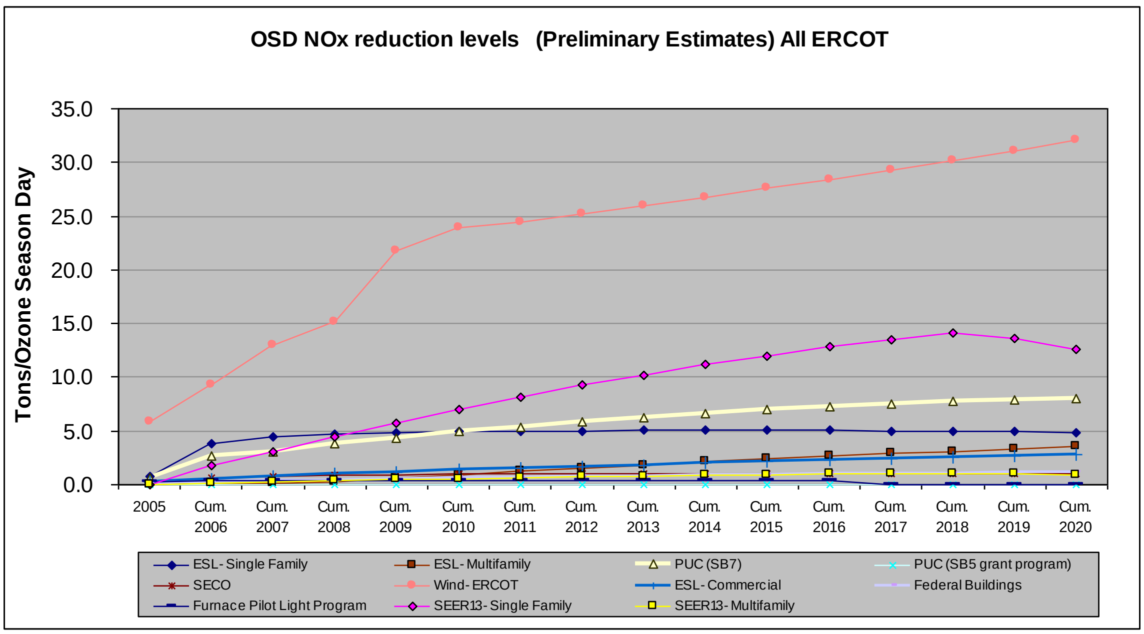


Figure 3: Cumulative OSD NOx Emissions Reduction Projected through 2020

3.7 Technology for Calculating and Verifying Emissions Reduction from Energy Used in Buildings

In 2004 and 2005, the Laboratory developed a web-based Emissions Reduction Calculator, known as "*eCalc*," which contains the underlying technology for determining NOx emissions reduction from power plants that generate the electricity for the user[10]. The emissions reduction calculator is being used to

[10] eCalc reports NOx, SOx and CO2 emissions reduction from the US EPA eGRID database for power providers in the ERCOT region.

calculate emissions reduction for consideration for SIP credits from energy efficiency and renewable energy programs in the TERP.

In 2007, the Laboratory enhanced the calculator to provide additional functions and usability, including:

- Renaming the product IC3 v2.0
- Enhanced the Laboratory's IECC/IRC Code-Traceable Test Suite for determining emissions reduction due to code and above-code programs;
- Enhanced web-based emissions calculator, including:
    - Use of the calculator to determine 15% above code residential and commercial options.
    - Gathered, cleaned and posted weather data archive for 17 NOAA stations;
    - Performed comparative testing of the calculator vs. other, non-web-based simulation programs;
    - Developed and tested radiant barrier simulation;
    - Using the web-based emissions calculator, started development of the derivative version Texas Climate Vision calculator for the City of Austin;
- Continued the development of verification procedures, including:
    - Completed the calibrated simulation of a high-efficiency office building in Austin, Texas;
    - Continued work to develop a calibrated simulation of an office building in College Station; and
    - Continued work to develop a calibrated simulation of a K-12 school in College Station;

In 2008, work on both web based calculators continued;

- Deployed IC3 v3.2 to handle a wider selection of single family building configurations (http://ic3.tamu.edu);
- Delivered TCV v1.0 to the City of Austin for their testing;
- Continued to operate the original eCalc;
- Supported modeling efforts by building enhanced tools for batch simulation;
- Provided training on both IC3 and TCV.

In 2009, IC3 developments included:

- A sister product, AIM was created for the State Comptroller's office.
- Usage statistics continue to climb.
- Updated to v3.6 which included 3 story houses, external cladding, more sophisticated ceiling/roof models, enhanced foundation modeling and the ability to copy projects.

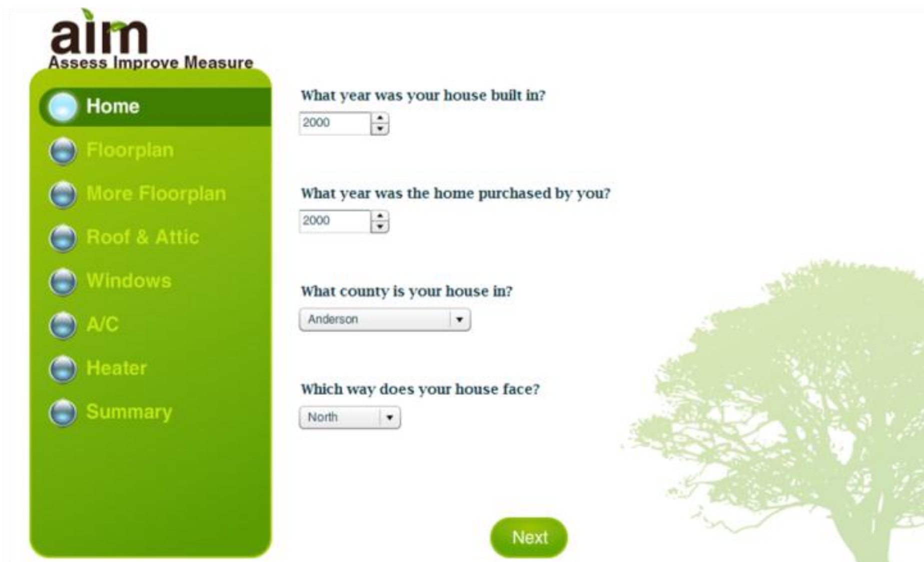


Figure 4: AIM Home Page

Figure 5: AIM Score Page

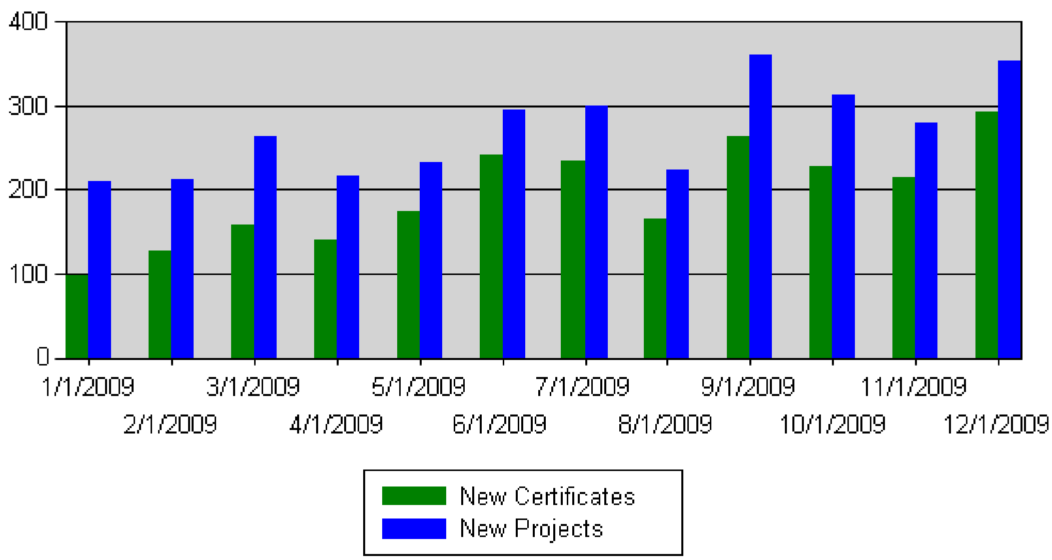


Figure 6: 12 monthly totals of new certificates and new projects in IC3 v 3.x

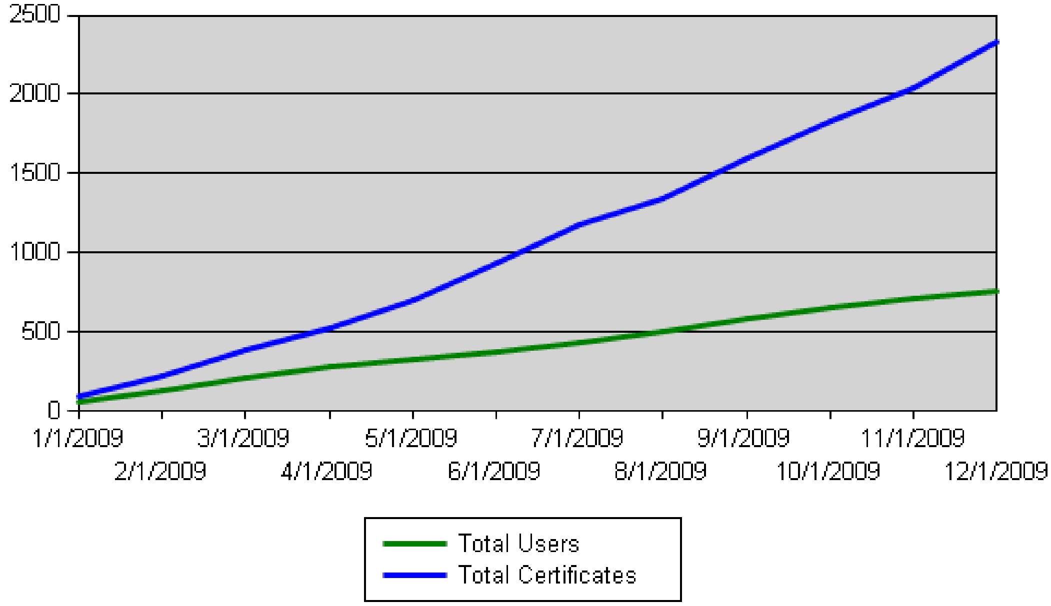


Figure 7: Last 12 months cumulative users and certificates in IC3 v3.x

3.8 Code Adoption

During the 77th Legislature, Senate Bill 5 (SB 5) adopted the 2000 International Residential Code (IRC) as the energy code for single-family residential construction and the 2000 International Energy Conservation Code (IECC), with the 2001 Supplement for all other residential, commercial and industrial construction in the state. This bill became law in 2001 and marks the first mandatory energy code requirements for the State of Texas and establishes the Texas Building Energy Performance Standards (TBEPS). Both codes require that municipalities establish procedures for administration and enforcement, and ensure that code-certified inspectors perform inspections.

State adoption of the 2000 Residential Code energy provisions and 2000 International Energy Conservation Code became effective September 1, 2001. A recent survey conducted by the Energy Systems Laboratory (ESL) indicates adoption of more recent editions of the International Energy Conservation Code (IECC), including the 2003, 2006, and 2009 editions, see tables below.

CITY NAME	Commercial Building Code (IBC)	Residential Building Code (IRC)	Energy Code (IECC)	Electrical Code (NEC)	Mechanical Code (IMC)	Plumbing Code (IPC)	Green Building Code	Existing Building Code (IEBC)	Other Codes
Abilene	2003	2003	2000	2008	2003	2003	N/A	2003	2003 IFGC
Addison									
Allen									
Amarillo	2006	2006	2006	2008	2006	2006	N/A	2006	2006 IFC, 2006 IFGC
Angleton									
Arlington	2003	2003	2003	2002	2003	2003	N/A	N/A	2003 IFC, 2003 IFGC
Austin									
Baytown	2006	2006	2006	2008	2006	2006	N/A	2006	N/A
Beaumont									
Bedford									
Big Spring	2006	2006	2006	2005	2006	2006	N/A	2006	N/A
Borger									
Brownsville	2006	2006	2006	2008	2006	2006	N/A	N/A	2006 IFGC
Bryan	2003	2003	2003	2002	2003	2003	N/A	2003	2003 IFGC
Burleson	2006	2006	2006	2005	2006	2006	N/A	N/A	North Central Texas Council of Government Amendment
Carrollton "	2006	2006	2006	2008	2006	2006	N/A	N/A	NCTCOG Recommended Regional Amendments
Cedar Hill	2006	2006	2006	2008	2006	2006	N/A	N/A	2006 IFGC
Cedar Park	2009	2009	2009	2008	2009	2009	N/A	2009	2006 IFC with Ammendments, 2009 IPMC
Cleburne	2003	2003	2003	2002	2003	2003	N/A	N/A	N/A
College Station	2009	2009	2009	2008	2009	2009	N/A	N/A	N/A
Conroe	2003	N/A	N/A	2008	2000	2000	N/A	N/A	2003 IFC
Coppell	N/A	2006	2006	2005	2006	2006	N/A	2006	2006 IFC, 2006 IFGC, 2006 IPMC
Copperas Cove									
Corpus Christi	2003	2003	2003	2002	2003	2003	N/A	N/A	N/A
Corsicana	2009	2009	N/A	2008	2009	2009	N/A	N/A	N/A
Dallas	2006	2006	2006	2008	2006	2006	City of Dallas Ordinance #081070	2003	2006 IFC, 2006 IFGC
Deer Park									
Del Rio									
Denton									

CITY NAME	Commercial Building Code (IBC)	Residential Building Code (IRC)	Energy Code (IECC)	Electrical Code (NEC)	Mechanical Code (IMC)	Plumbing Code (IPC)	Green Building Code	Existing Building Code (IEBC)	Other Codes
Desoto	2003	2003	2003	2002	2003	2003	N/A	N/A	N/A
Devine									
Duncanville	2008	2008	2008	2008	2008	2008	N/A	N/A	2006 IFGC, 2006 IPMC
Eagle Pass	2009	2009	2009	2008	2006	2009	N/A	2006	N/A
Edinburg									
El Paso									
Euless	2003	2003	2003	2002	2003	2003	N/A	N/A	2003 IFC, 2003 IFGC, 2003 IPMC
Farmers Branch									
Flower Mound									
Fort Worth	2003	2003	2003	2008	2003	2003	N/A	N/A	2003 IFGC
Friendswood	2009	2009	2009	2008	2009	2009	N/A	N/A	N/A
Frisco									
Galveston	2009	2009	2009	2008	2009	2009	N/A	N/A	2009 IFC, 2009 IPMC
Garland	2003	2003	2003	2005	2003	2003	N/A	N/A	N/A
Georgetown	2003	2000	2000	2002	2003	2003	N/A	2003	N/A
Grand Prairie	2003	2003	2003	2005	2003	2003	N/A	N/A	2003 IFC, 2003 IFGC
Grapevine	2006	2006	eferenc	2005	2006	2006	N/A	2006	N/A
Greenville	2006	2006	2006	2005	2006	2006	N/A	2006	N/A
Haltom City	2003	2003	2003	2002	2003	2003	N/A	N/A	N/A
Harker Heights	2009	2009	2008	2008	2009	2009	N/A	2006	2009 IFC, 2009 IFGC
Harlingen									
Houston									
Huntsville	2003	2003	2003	2005	2003	2003	N/A	N/A	2003 IFC, 2003 IFGC, 2003 IPMC
Hurst	2003	2003	2003	2005	2003	2003	N/A	N/A	2003 IPMC
Irving	2006	2006	2006	2008	2006	2006	N/A	N/A	2006 IFC, 2006 IFGC
Keller	2006	2006	2006	2008	2006	2006	N/A	N/A	2006 IFGC
Killeen									
Kingsville									
Kyle	2000	2000	2000	1999	2000	2000	N/A	N/A	2000 IPMC
La Porte									
Lake Jackson									
Lancaster	2003	2003	2003	2002	2003	2003	N/A	N/A	2003 IPMC

CITY NAME	Commercial Building Code (IBC)	Residential Building Code (IRC)	Energy Code (IECC)	Electrical Code (NEC)	Mechanical Code (IMC)	Plumbing Code (IPC)	Green Building Code	Existing Building Code (IEBC)	Other Codes
Laredo	2009	2009	2009	2008	2009	2009	N/A	2009	N/A
League City	2006	2006	2006	2005	2006	2006	N/A	2006	N/A
Leander	2009	2009	2009	2008	2009	2009	N/A	2009	N/A
Lewisville	2006	2006	2006	2005	2006	2006	N/A	N/A	North Texas Regional Council of Governments Amendments to International Codes
Longview									
Lubbock									
Lufkin	2006	2006	N/A	2005	2006	2006	N/A	2006	N/A
Mansfield	2006	2006	2006	2005	2006	2006	N/A	N/A	2006 IFGC
McAllen	2006	2006	2006	2008	2006	2006	N/A	N/A	2006 IFGC
McKinney	2006	2006	2006	2005	2006	2006	N/A	N/A	N/A
Mesquite									
Midland	2009	2009	2009	2008	2009	2009	N/A	N/A	N/A
Mission									
Missouri City	2006	2006	2006	2005	2006	2006	N/A	N/A	2006 IPMC
Nacogdoches	2006	2006	2006	2005	2006	2006	N/A	N/A	2006 IFC
New Braunfels	2006	2006	2006	2005	2006	2006	N/A	2006	2006 IFC, 2006 IPMC
North Richland									
Odessa									
Paris									
Pasadena	2006	2006	2006	2008	2006	2006	N/A	N/A	2006 IPMC
Pearland	2006	2006	2006	2005	2006	2006	dinance, NO MOD	2006	2006 IPMC
Pflugerville									
Pharr	2003	2003	2009	2002	2003	2003	N/A	2003	2003 IFC, 2003 IPMC
Plano									
Port Arthur	2006	2006	2006	2002	2006	2006	N/A	1997	N/A
Richardson	2006	2006	2006	2005	2006	2006	N/A	N/A	N/A
Rockwall	2006	2006	2006	2005	2006	2006	N/A	N/A	2006 IFC
Rosenberg									
Round Rock	2006	2006	2006	2008	2006	2006	N/A	2006	N/A
Rowlett									
San Angelo									

CITY NAME	Commercial Building Code (IBC)	Residential Building Code (IRC)	Energy Code (IECC)	Electrical Code (NEC)	Mechanical Code (IMC)	Plumbing Code (IPC)	Green Building Code	Existing Building Code (IEBC)	Other Codes
San Antonio									
San Benito	2009	2009	2009	N/A	2009	2009	N/A	N/A	2009 IFGC, 2009 IPMC, 2009 IWUIC
San Juan	2006	2006	2006	2008	2006	2006	N/A	2006	2006 IFC/Hurricane Resistant Residential Construction
San Marcos									
Schertz									
Seguin	2006	2006	2006	2005	2006	2006	N/A	2006	N/A
Sherman	2006	2006	2006	2005	2006	2006	N/A	N/A	N/A
Socorro	2003	2003	2003	2003	2003	2003	2003	2003	N/A
Southlake	2006	2006	2006	2008	2006	2006	N/A	N/A	N/A
Sugar Land	2003	2003	2003	2005	2003	2003	N/A	2003	2003 IFC, 2003 IFGC, 2003 IPMC
Temple	2006	2006	2006	2008	2006	2006	N/A	N/A	2006 IFGC, 2006 IPMC
Texarkana									
Texas City	2006	2006	2006	2006	2006	2006	2006	2006	N/A
The Colony	2006	2006	2006	2008	2006	2006	N/A	N/A	N/A
Tyler									
Victoria									
Waco *	2009	2009	2009	2008	2009	2009	N/A	2009	2009 IFC, 2009 IFGC, 2009 IPMC
Waxahachie									
Weatherford									
Weslaco									
Wichita Falls	2006	2006	2006	2008	2006	2006	N/A	2006	N/A

In general, the State has enjoyed a true market transformation in the supply of certain products, such as Low Solar Gain windows11.

The International Energy Conservation Code (IECC) is published by the International Code Council (ICC). The current code cycle dictates that a new edition is released every three years and supplements in the intervening years. The first publication of the 2009 International Energy Conservation Code became available in March of 2009. Energy Systems Laboratory reviewed and considered comments received by the State Energy Conservation Office (SECO) and performed a technical analysis to compare the stringency of the TBEPS, based on the 2000 IECC with the 2001 Supplement to the 2009 IECC and Chapter 11 of the 2009 IRC. The analysis of the 2009 IECC and Chapter 11 of the 2009 IRC are as

[11] http://www.energycodes.gov/implement/pdfs/shgc.pdf

stringent as the TBEPS, and the 2009 IECC is marginally more stringent than the 2009 IRC for residential energy efficiency. The Laboratory then made recommendations to SECO to adopt the 2009 IECC and Chapter 11 of the 2009 IRC as the new energy code for the State of Texas.

Our emphasis in 2009 has been on the continued delivery of training aimed at assisting municipal inspectors to become certified energy inspectors (in one of several designations maintained by the International Energy Code Council) and supporting code officials with guidance on interpretations as needed. This effort, begun in 2003 and based on a requirement of HB 3235 of the 78th Texas Legislature, is designed to support a more uniform interpretation and application of energy codes throughout the state.

ENERGY SYSTEMS LABORATORY
Texas Engineering Experiment Station
Texas A&M University System

3581 TAMU
College Station, Texas 77843-3581

September 29th, 2009

Mr. Felix Lopez, P.E.
Senior Engineer
State Energy Conservation Office
Comptroller of Public Accounts
111 East 17th Street, Room 114
Austin, Texas 78701

Dear Felix:

In accordance with the Health and Safety Code Section 388.003, as amended, the Laboratory reviewed and considered the comments received and performed a technical analysis that compared the stringency of the Texas Building Energy Performance Standards, based on the 2000 International Energy Conservation Code with the 2001 Supplement (2000/2001 IECC), to the 2009 IECC and Chapter 11 of the 2009 IRC.

The Laboratory recommends that Texas, through the State Energy Conservation Office's (SECO) rulemaking process, adopt the 2009 IECC and the Chapter 11 of the 2009 IRC, as statewide energy codes. The state should immediately begin educating, training, and providing technical assistance for building professionals and enforcement officials to enable statewide compliance.

The Laboratory's analysis has determined that:

1. For residential construction with 15% or less window to floor ratio, the residential prescriptive provisions of the 2009 IECC and the Chapter 11 of the 2009 IRC are as stringent as the Texas Building Energy Performance Standards (TBEPS), which is based on the 2000/2001 IECC (see attached tables for details). The Laboratory's analysis of the 2009 IECC and the Chapter 11 of the 2009 IRC indicate a marginal improvement in overall residential energy efficiency of the 2009 IECC over the energy provisions of the 2009 IRC.

2. For all other residential structures, the residential performance provisions of the 2009 IECC are as stringent as the TBEPS based on the 2000/2001 IECC.

3. The commercial provisions of the 2009 IECC are as stringent as the TBEPS based on the 2000/2001 IECC.

The Laboratory recognizes that several major municipalities are in the process of adopting energy codes that are equal to the 2009 IECC and/or the energy provisions of the 2009 IRC Codes. Although builders, suppliers, and manufacturers will be required to meet the newly adopted codes, and will need to retrain their employees and restock their supplies to meet the new requirements of the more stringent code, implementation of improved codes should be effected as soon as possible in order to maximize desired emissions reductions. An increased number of raters, inspectors and code officials will also be required to handle the increased demand. The Laboratory recognizes the challenge of these efforts and is ready to assist SECO. The Laboratory is also in the process of updating the International Code Compliance Calculator (IC3) to facilitate compliance with the new residential provisions of the 2009 IECC.

Notwithstanding the comparisons in overall energy efficiency, the Laboratory observes the potentially greater reduction in peak demand associated with the 0.30 SHGC limitations found in the 2009 IECC. This, in addition to the corresponding emissions reduction resulting from the peak demand savings, provides enhanced benefits over a higher SHGC in compliance with the goals of the Texas Building Energy Performance Standards in the Health & Safety Code Section 388. 001.

The Laboratory recommends compliance with the 2009 IECC or the Chapter 11 of the 2009 IRC when using the prescriptive path for residential evaluation of residences with 15% or less window to floor ratio, since both are more stringent than the current TBEPS. The Laboratory also recommends using the 2009 IECC when using the performance path for all other residential evaluations.

These new codes will further Texas' Emission Reduction Plan (TERP) goals in improving air quality. Furthermore, adoption of the 2009 IECC is a requirement for securing American Recovery and Reinvestment Act (ARRA) Federal funding for Texas.

Sincerely,

Bahman Yazdani, P.E.	Charles Culp, P.E., Ph.D.	Jeff Haberl, P.E., Ph.D.
Associate Director	Associate Director	Associate Director

cc: David Claridge, P.E., Ph.D., Director – ESL

Section 388.009 of HB 3235 requires the Laboratory to develop and administer a state-wide training program for municipal building inspectors who seek to become code-certified inspectors. To accomplish this, the Laboratory developed the Energy Code Workshops which are based on the 2006 International Energy Conservation Code (IECC) as published by the International Code Council (ICC) for residential and commercial buildings, with amendments. In addition, more workshops were developed that offered software training on the International Code Compliance Calculator (IC3) and ASHRAE Standard 90.1-2007.

H.B. No. 3235

AN ACT

relating to certification training programs for municipal building inspectors and the implementation of Texas building energy efficiency performance standards by certified municipal building inspectors.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF TEXAS:

SECTION 1. Chapter 388, Health and Safety Code, is amended by adding Section 388.009 to read as follows:

Sec. 388.009. CERTIFICATION OF MUNICIPAL BUILDING INSPECTORS. The laboratory shall develop and administer statewide a training program for municipal building inspectors seeking to become code-certified inspectors. The laboratory shall also work with national code organizations to assist participants in the certification program. The laboratory may collect reasonable fees from participants in the program to pay the costs of administering the program.

SECTION 2. Not later than January 1, 2004, the Energy Systems Laboratory at the Texas Engineering Experiment Station of The Texas A&M University System shall have developed the training program required by Section 388.009, Health and Safety Code, as added by this Act, and not later than March 1, 2004, shall begin implementing the training program statewide.

SECTION 3. Notwithstanding Section 11(d), Chapter 967, Acts of the 77th Legislature, Regular Session, 2001, a municipality is not required to comply with Section 388.003(c)(2), Health and Safety Code, before March 1, 2005.

____

President of the Senate

I certify that H.B. No. 3235 was passed by the House on May 2, 2003, by a non-record vote.

____

Chief Clerk of the House

I certify that H.B. No. 3235 was passed by the Senate on May 27, 2003, by the following vote: Yeas 31, Nays 0.

Secretary of the Senate

APPROVED: ____________________

Date

____

Governor

The Residential Energy Code Training Workshop and Commercial Requirements of the International Energy Conservation Workshop both include an overview of the TERP program and extensive instruction on all chapters of the IECC, which include the general requirements, definitions, and design conditions. The 2006 Residential Workshops also include detailed instruction on chapters(s) containing specific regulations relating to residential construction, in addition to a comparison of the IECC and the energy provisions of the International Residential Code (IRC).

2006 IECC Residential Provisions with Texas Amendments

Energy Systems Laboratory,
Texas A&M University System and
State Energy Conservation Office

SECO

SPECIAL THANKS TO

SECO
State Energy Conservation Office

Felix Lopez, P.E.
Senior Engineer

SECO

Shirley Muns
muns@tamu.edu

- Energy Codes Specialist, Energy Systems Laboratory, Texas Engineering Experiment Station, Texas A&M University System
- Certified Building Official, since 1987
- Serving on the ICC International Energy Conservation Code Development Committee
- 20+ years as a Building Inspector/Official, including residential, high-rise, commercial and industrial
- Instructor for ICC Code training – Code Development, Building, Residential, Energy Codes and Green Building and Sustainability

SECO Energy Systems Laboratory 3

Kathy McKelvey
Kmckelvey@tamu.edu

- Texas A&M's Energy Systems Laboratory Engineering Research Associate since Sept 2007
- City of Fort Worth Chief Residential Inspector for 11 years. Holds numerous ICC Certifications.
- State of Texas Plumbing Inspectors' License
- Master Sign Electrician License
- Certified Home Energy Rater

SECO Energy Systems Laboratory 4

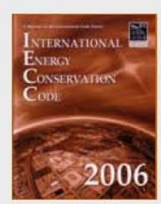
Ed Dryden
Ed.Dryden@arlingtontx.gov

- Building Official, City of Arlington, Texas
- 24 years experience in municipal code enforcement
- Certified Building Official & other ICC Certifications
- Involved in North Central Texas Council of Governments regional code review process

SECO Energy Systems Laboratory 5

Today's Class Structure

- Why Energy Codes - Intent
- Structure of the Energy Codes
- Administration
- Residential
- Compliance Software Tools
- Resources



SECO Energy Systems Laboratory 6

Why Energy Codes?

- It's the law
- Minimum regulations for energy efficient buildings
- Energy used primarily for "human comfort"
- Benefits
  - Reduce air pollution
  - Moderate peak electrical power demands
  - Improve comfort
  - Reduce costs for residents

SECO Energy Systems Laboratory 7

Basic Methods of Heat Transfer

Conduction
The transfer of heat through a solid material, moving from warmer to cooler particles that are in direct physical contact.

Convection (infiltration, exfiltration)
The transfer of heat through a moving fluid, either gas or liquid. The most common driving force for convective heat transfer is the tendency of a warm fluid to rise due to its lighter density.

Radiation
The transfer of heat by electromagnetic waves from a warmer to a cooler surface, where the medium is not affected by the transfer.
For example, radiating heat from a person to a cold window surface.

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Structure of Energy Code

- Chapter 1 Administration
- Chapter 2 Definitions
- Chapter 3 Climate Zones
- Chapter 4 Residential Energy Efficiency
- Chapter 5 Commercial Energy Efficiency
- Chapter 6 Referenced Standards

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Texas Amendments

- North Central Texas Council of Governments – Applies statewide
- Stringency verified by Energy Systems Laboratory, Texas Engineering Experiment Station, Texas A&M University System

SECO Energy Systems Laboratory 10

Administration *(Section 101.4)*

- Establishes minimum regulations
  - Detached One- and Two-family
  - Type R-2, R-4 or Townhouse buildings
  - Commercial and High-Rise Multifamily
- Regulates design and selection of
  - Building envelope
  - Mechanical systems
  - Service water heating systems
  - Electrical power and lighting systems

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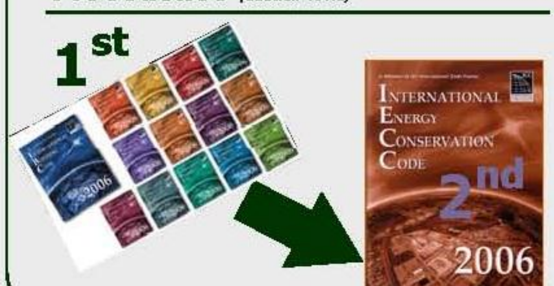
Precedence *(Section 101.3)*



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Scope: Residential *(Section 202)*
(What types of buildings covered?)

Detached One- and Two-family Dwellings

R-2, R-3, R-4, Low-Rise Multi-family ≤3 stories

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Scope *(Section 101.4)*

- **New construction** *(Section 101.2)*
- **Existing buildings** *(Section 101.4.1)*
- **Historic buildings** *(Section 101.4.2)*
- **Additions** *(Section 101.4.3)*
- **Change in Occupancy** *(Section 101.4.4)*
- **Mixed occupancy** *(Section 101.4.5)*

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Historic *(TX Section 101.4.2)*

- Buildings officially identified as
  - Listed in the State or National Register of Historic Places
  - Designated under local or state designation law
  - Certified as a contributing resource in a designated historic district
  - Certification that the property is eligible to be listed, individually or as a contributing building
    - State Historic Preservation Officer
    - Keeper of the National Register of Historic Places
- shall comply with all of the provisions of this code.

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Exception

- Whenever a provision or provisions shall invalidate or jeopardize the historical designation or listing, that provision or provisions may be exempted.

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Additions, Alterations, Renovations or Repairs *(Section 101.4.3)*

- Applies as it relates to new construction
- Without requiring the unaltered portion to comply
- Exceptions

SECO Energy Systems Laboratory 17

Exceptions

- Storm windows over existing fenestration
- Glass only replacements in an existing sash and frame
- Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation
- Construction were the existing roof, wall or floor cavity is not exposed

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Change in Occupancy *(Section 101.4.4)*

- Change would result in an increase in
  - Fossil fuel demand, OR
  - Electrical energy use

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Low Energy Use Buildings *(Section 101.5.2)*

The following are exempt

- <3.4 Btu/h-ft^2 or 1 Watt/ft^2 of floor area
- Do not contain conditioned space

Note: Exempt from the building thermal envelope provisions only

SECO Energy Systems Laboratory 20

Material Identification *(Section 102.1)*

SECO Energy Systems Laboratory 21

Fenestration Product Rating

- Testing Standards
  (Section 102.1.3)
  - *U*-factors – NFRC 100 or Table 102.1.3(1) or 102.1.3(2)
  - SHGC – NFRC 200 or Table 102.1.3(3)

SECO Energy Systems Laboratory 22

Alternative compliance *(TX Section 103.3.1.1)*

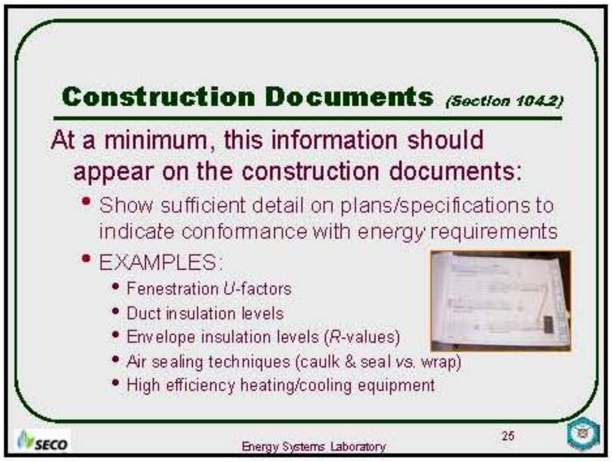
- A building certified by a national, state, or local accredited energy efficiency program and determined by the Energy Systems Laboratory to be in compliance with the energy efficiency requirements of this section may, at the option of the Code Official, be considered in compliance. The United States Environmental Protection Agency's Energy Star Program certification of energy code equivalency shall be considered in compliance
- This amendment is added to allow alternative compliance in accordance with Texas HB 1365, 78th Legislature

SECO Energy Systems Laboratory 23

Maintenance Information *(Section 102.3)*

- Instructions for homeowner
  - Preventative maintenance instructions
    - Equipment and Systems
    - Clearly stated and incorporated on a readily accessible label
      - Including the title or publication number for the operation and maintenance manual for that particular model and type of product

SECO Energy Systems Laboratory 24


Construction Documents (Section 104.2)
At a minimum, this information should appear on the construction documents:
• Show sufficient detail on plans/specifications to indicate conformance with energy requirements
• EXAMPLES:
• Fenestration U-factors
• Duct insulation levels
• Envelope insulation levels (R-values)
• Air sealing techniques (caulk & seal vs. wrap)
• High efficiency heating/cooling equipment
SECO
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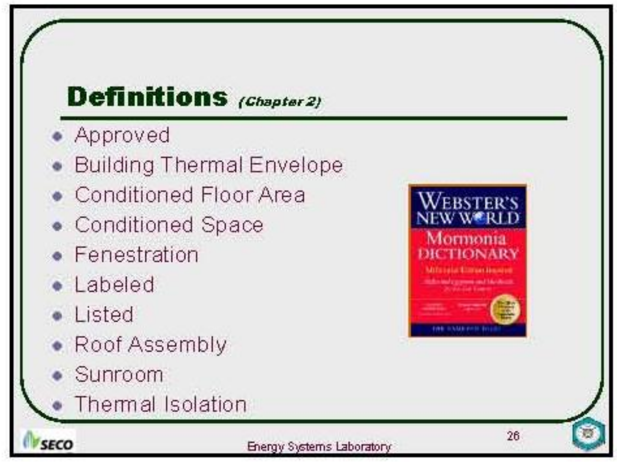
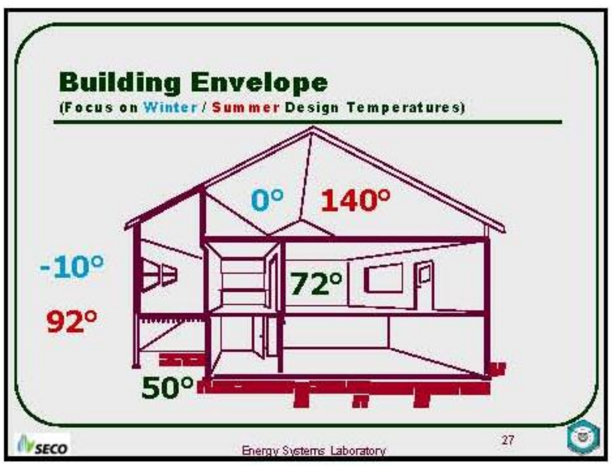

Definitions (Chapter 2)
• Approved
• Building Thermal Envelope
• Conditioned Floor Area
• Conditioned Space
• Fenestration
• Labeled
• Listed
• Roof Assembly
• Sunroom
• Thermal Isolation
WEBSTER'S NEW WORLD
Mormonia
DICTIONARY
SECO
Energy Systems Laboratory
26


Building Envelope
(Focus on Winter / Summer Design Temperatures)
0°
140°
-10°
72°
92°
50°
SECO
Energy Systems Laboratory
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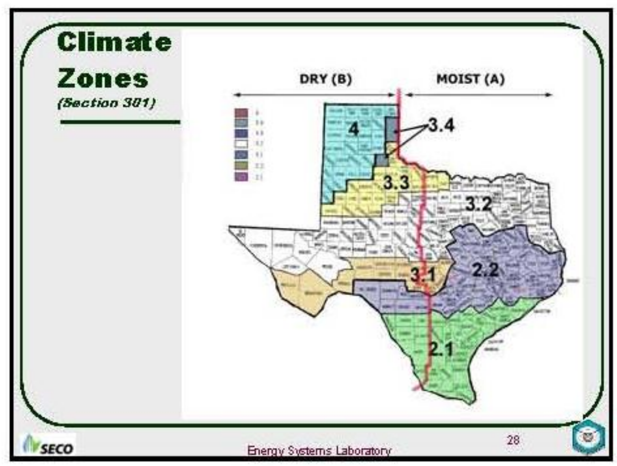
Climate Zones
(Section 301)
DRY (B)
MOIST (A)
4
3.4
3.3
3.2
3.1
2.2
2.1
SECO
Energy Systems Laboratory
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TABLE 301.1(1) CLIMATE ZONES AND SUBCLIMATE ZONES FOR TEXAS
Zone 2
SECO
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29


Zone 3
SECO
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30

Zone 3 Con't.	DAWSON	3.3	JEFF DAVIS	3.2	PECOS	3.2	WHEELER	3.4
	DELTA	3.2	JOHNSON	3.2	PRESIDIO	3.1	WICHITA	3.3
	DENTON	3.2	JONES	3.2	RAINS	3.2	WILBARGER	3.3
	DICKENS	3.3	KAUFMAN	3.2	REAGAN	3.2	WINKLER	3.2
	EASTLAND	3.2	KENDALL	3.1	RED RIVER	3.2	WISE	3.2
	ECTOR	3.2	KENT	3.3	REEVES	3.2	WOOD	3.2
							YOUNG	3.2

Zone 4	ARMSTRONG	DEAF SMITH	HOCKLEY	PARMER
	BAILEY	DONLEY	HUTCHINSON	POTTER
	BRISCOE	FLOYD	LAMB	RANDALL
	CARSON	GRAY	LIPSCOMB	ROBERTS
	CASTRO	HALE	MOORE	SHERMAN
	COCHRAN	HANSFORD	OCHILTREE	SWISHER
	DALLAM	HARTLEY	OLDHAM	YOAKUM

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Chapter 4

Residential Energy Efficiency

Compliance *(Section 401.2)*

- Mandatory - Comply with
  - 401 (General), 402.4 (Air Leakage), 402.5 (Moisture Control), 402.6 (Maximum Fenestration *U*-factor and SHGC), AND
  - 403 (Systems)
- Performance – Comply with either
  - Building Thermal Envelope Sections 402.1 (General), 402.2 (Specific insulation Requirements), and 402.3 (Fenestration); OR
  - Section 404 (Simulated Performance Alternative)

Energy Systems Laboratory 33

Compliance Software tools
(TX Section 401.2.1)

- Software tools used to demonstrate energy code compliance that are deemed acceptable by the building official may only utilize the energy chapter of the 2001 or the 2003 International Residential Code when code edition selection is available.
  - This amendment is added to satisfy the "not less restrictive" requirement when adopting subsequent editions of energy codes in accordance with Texas SB 5, 77th Legislature

Energy Systems Laboratory 34

Certificate *(Section 401.3)*

- Permanent certificate posted on or in the electrical distribution panel
  - *R*-values – ceiling/roof, walls, foundation (slab, basement wall, crawlspace wall and/or floor) and ducts located outside building envelope
  - *U*-factors – fenestration and SHGC
  - Type and efficiency of HVAC and service water heating
- If there is more than one value, list the value covering the largest area

Energy Systems Laboratory 35

TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE	BASEMENT[c] WALL R-VALUE	SLAB[d] R-VALUE & DEPTH	CRAWL SPACE[c] WALL R-VALUE
1	1.20	0.75	0.40	30	13	3	13	0	0	0
2	0.75	0.75	0.40	30	13	4	13	0	0	0
3	0.65	0.65	0.40[e]	30	13	5	19	0	0	5/13
4 except Marine	0.40	0.60	NR	38	13	5	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	19 or 13+5[g]	13	30[f]	10/13	10, 2 ft	10/13
6	0.35	0.60	NR	49	19 or 13+5[g]	15	30[f]	10/13	10, 4 ft	10/13
7 and 8	0.35	0.60	NR	49	21	19	30[f]	10/13	10, 4 ft	10/13

For SI: 1 foot = 304.8 mm.
a. R-values are minimums. U-factors and SHGC are maximums. R-19 shall be permitted to be compressed into a 2 × 6 cavity.
b. The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
c. The first R-value applies to continuous insulation, the second to framing cavity insulation; either insulation meets the requirement.
d. R-5 shall be added to the required slab edge R-values for heated slabs.
e. There are no SHGC requirements in the Marine zone.
f. Or insulation sufficient to fill the framing cavity, R-19 minimum.
g. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

Energy Systems Laboratory 36

Building Envelope Requirements

Table 402.1.1
Insulation and Fenestration Requirements by Component[a]

- *R*-values are minimums. *U*-factors and SHGC are maximums. R-19 shall be permitted to be compressed into a 2 x 6 cavity.
- The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
- R-5 shall be added to the required slab edge *R*-values for heated slabs.
- The total *R*-value may be achieved with a combination of cavity and insulating sheathing that covers 100% of the exterior wall.
- The wall insulation may be the sum of the two values where the first value is the cavity insulation and the second value is insulating sheathing. The combination of cavity insulation plus insulating sheathing may be used where structural sheathing covers not more than 25% of the exterior wall area and insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of exterior wall area then the wall insulation requirement may only be satisfied with the single insulation value.

SECO Energy Systems Laboratory 37

Insulation Criteria (TX Section 402.1.1)

- When compliance using Table 402.1.1 is demonstrated with a ceiling *R*-value of R-30 or less, no more than 33% of the total projected ceiling area may be of cathedral type construction (ceiling joist/roof rafter assembly) and the required insulation *R*-value may be reduced to a minimum of R-22 insulation when the remaining ceiling area insulation is increased to R-38.

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Poor Insulation Installation

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Poor Insulation Installation

SECO Energy Systems Laboratory 40

U-factor Alternative *(Section 402.1.3)*

- Assemblies with a *U*-factor ≤ those specified in Table 402.1.3 are permitted as an alternative to the *R*-value in Table 402.1.1.

SECO Energy Systems Laboratory 41

Total *UA* Alternative *(Section 402.1.4)*

- Sum of *U*-factor times assembly area ≤ total *UA* resulting from using Table 402.1.3, the building shall be considered in compliance
  - Must use the same assembly area in both
  - SHGC must still be met
  - Use a method consistent with the ASHRAE *Handbook of Fundamentals*

SECO Energy Systems Laboratory 42

Specific Insulation Requirements

- Ceilings with attic space *(Section 402.2.1)*
  - Exception for Energy Trusses
    - R-38 reduced to R-30
    - R49 reduced to R-38
- Ceilings without attic space *(Section 402.2.2)*
  - Exception for insufficient depth
    - A maximum of R-30 may be used
    - Limited to 500 ft^2 of ceiling area

SECO Energy Systems Laboratory 43

Ceilings

(Section 102.5.1)

This Attic Has Been Insulated To

ICAA R-

By A Professional Insulation Contractor

The insulation in this attic was installed by a qualified professional Contractor to the R-value stated above

Certificate of Insulation

BUILDING ADDRESS: ____________ CONTRACTOR: ____________

Installation Date: ____________ License #: ____________

Area Insulated	R-Value	Installed Thickness	Settled Thickness	Installed Density	No. Bags	Sq. Ft.
Attic						
Walls						
Floors						

I, ____________, (print name) certify that this residence/building has been insulated to the stated R-value and that the installation is in conformance with all applicable codes, standards, regulations and specifications

Authorized Signature: ____________ Date: ____________

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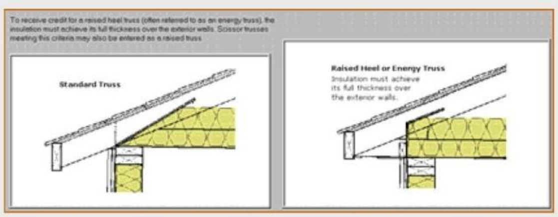
Raised-Heel Trusses



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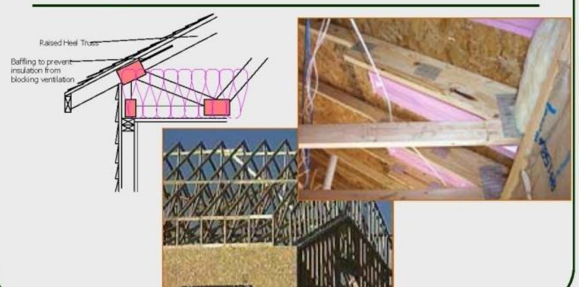
Energy or Raised Heel Trusses



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What are Mass Walls? *(Section 402.2.3)*

Concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (not including brick veneer), earth (including adobe, compressed earth block, rammed earth) and solid timber/logs

SECO Energy Systems Laboratory 47

Steel Frame Construction

(Section 402.2.4)

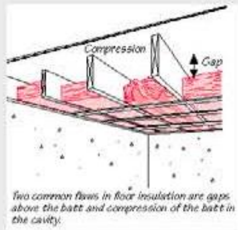
Table 402.2.4 or shall meet *U*-factor in Table 402.1.3

Based on wood-framed wall *R*-value

SECO Energy Systems Laboratory 48

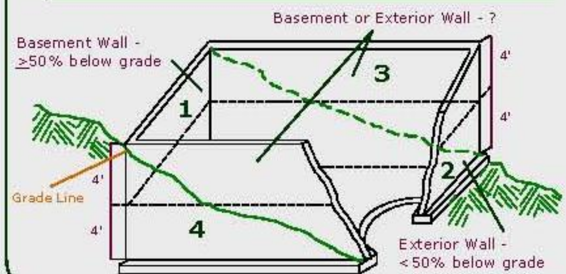
Floors *(Section 402.2.5)*

- Floor insulation must maintain permanent contact with the underside of the subfloor decking



SECO Energy Systems Laboratory 49

True Basement Walls



SECO Energy Systems Laboratory 50

Insulation Protection *(Section 102.2.1)*

- Exterior insulation applied to basements, crawlspace walls and the perimeter of slab-on-grade floors shall be protected
  - Rigid, opaque, weather-resistant
  - Cover the exposed insulation
  - Extend at least 6" below grade

SECO Energy Systems Laboratory 51

Slab-on-Grade Floors *(Section 402.2.7)*

- With a floor surface less than 12" below grade
- Not required in jurisdictions designated as having a very heavy termite infestation
- Not required on horizontal portion of the foundation supporting masonry veneer *(Section 402.2.9)*

SECO Energy Systems Laboratory 52

Slab-Edge Insulation

SECO Energy Systems Laboratory 53

Insulated Crawlspace? *(Section 402.2.8)*

- No ventilation openings allowed *(IRC Section R408)*
  - Provide continuously operating mechanical ventilation at 1 CFM/50ft^2; *(Exception 4)*, or
  - Provide conditioned air to crawlspace *(Exception 5)*
- Insulation fastened to the wall
  - Extend at least 24" vertically and/or horizontally
- Exposed earth covered with a continuous vapor barrier
  - Overlap 6" and attached

SECO Energy Systems Laboratory 54

Thermally Isolated Sunroom
(Section 402.2.10)

- Walls
  - R-13, all zones
  - New walls separating a sunroom from conditioned space must meet the building thermal envelope requirements
- Ceiling Insulation
  - Climate Zones 1 – 4 = R-19
  - Climate Zones 5 – 8 = R-24

SECO Energy Systems Laboratory 55

Insulation Installed in Walls
(TX Section 402.2.11)

- Insulation batts installed in walls shall be totally surrounded by an enclosure on all sides consisting of framing lumber, gypsum, sheathing, wood structural panel sheathing, or other equivalent material approved by the building official

SECO Energy Systems Laboratory 56

Fenestration *(Section 402.3)*

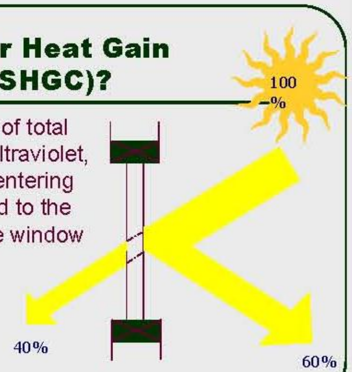
- Area-weighted average satisfies *U*-factor requirements *(Section 402.3.1)*
- Area-weighted average of products more than 50% glazed satisfies the SHCG requirements *(Section 402.3.2)*
  - In sub-climate zones 2.1, 2.2, 3.1, 3.2, and 3.3 the maximum area weighted average and the maximum SHCG shall not exceed 0.4 due to the "not less restrictive" requirement

SECO Energy Systems Laboratory 57

What is Solar Heat Gain Coefficient (SHGC)?

SHGC is the fraction of total incident solar heat (ultraviolet, visible and infrared) entering the window compared to the solar heat striking the window

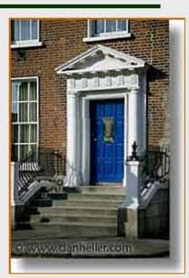
A SHGC of 0.40 means that 40% of the solar heat passes through the window



SECO Energy Systems Laboratory 58

Exemptions *(TX Section 402.3.3 and 402.3.4)*

- Fenestration - up to 1 percent per dwelling unit may be exempt from *U*-factor and SHGC
  - Changed from 15 sq.ft. due to the "not less restrictive" requirement
- One opaque door assembly is exempted from the *U*-factor



SECO Energy Systems Laboratory 59

Sunroom *U*-factor *(Section 402.3.5)*

- New windows and door separating the sunroom from the conditioned space must meet the building thermal envelope requirements

SECO Energy Systems Laboratory 60

Replacement Fenestration
(TX Section 402.3.6)

- Replacement of some or all of an existing fenestration it shall
  - Meet *U*-factor and SHGC from 402.3.7
- Exceptions
  - Skylights maximum *U*-factor = 0.60 in all subclimate zones except for 2.1
  - Building constructed in conformance with an energy code per SB5, replacement units may comply with the original construction documents

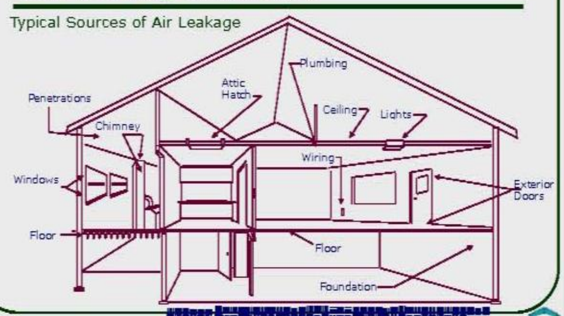
SECO Energy Systems Laboratory 61

Prescriptive Path for Additions
(TX Section 402.3.7)

- Additions less than 500 sq. ft. shall meet
  - Envelope component criteria in Table 402.3.7
  - *U*-factor of each fenestration product used to calculate area weighted average not to exceed the values in Table 402.3.7
  - Additions, other than sunrooms, shall have fenestration not exceeding 40% of the gross wall and roof area
  - R-values shall be $\geq$ than Table 402.3.7

SECO Energy Systems Laboratory 62

Air leakage *(Section 402.4)*



SECO Energy Systems Laboratory 63

Building Envelope Infiltration
(Section 402.4.1)

1. All joints, seams and penetrations
2. Site-built windows, doors and skylights
3. Openings between window and door assemblies and their frames
4. Utility penetrations
5. Dropped ceilings or chases adjacent to thermal envelope
6. Knee walls
7. Walls and ceilings at garage
8. Behind tubs and showers on exterior walls
9. Between dwelling units
10. Other sources of infiltration

SECO Energy Systems Laboratory 64

Understanding sealing?

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Infiltration Controls - Electrical

SECO Energy Systems Laboratory 66

Air Infiltration - HVAC

SECO Energy Systems Laboratory 67

Air Infiltration - Plumbing

SECO Energy Systems Laboratory 68

Fenestration Air Leakage *(Section 402.4.2)*

- Manufactured window and door infiltration rates
  - Windows, skylights - 0.3 cfm
  - Sliding-glass doors – 0.3 cfm
  - Swinging doors – 0.5 cfm
- Exception: site-built windows, skylights and doors

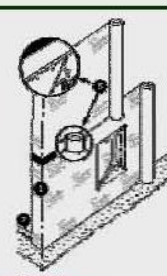
SECO Energy Systems Laboratory 69

Recessed Lighting Fixture
(Section 402.4.3)

SECO Energy Systems Laboratory 70

Moisture Control

Identify the "drainage plane?"

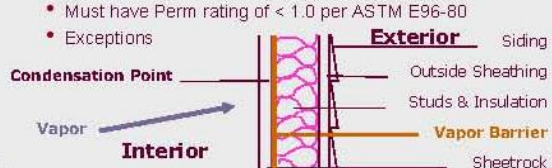


SECO Energy Systems Laboratory 71

Moisture Control *(Section 402.5)*

Vapor Retarder, Basic Requirements

- Install on "warm-in-winter side" of insulation
- Use in unvented framed above-grade walls, floors, and ceilings
- Must have Perm rating of < 1.0 per ASTM E96-80
- Exceptions



SECO Energy Systems Laboratory 72

Exceptions

- Where moisture or its freezing will not damage the materials
- Frame walls, floors and ceilings in Zones 1 – 4
  - Crawl space floor vapor retarders are not exempted
- Where other approved means to avoid condensation are provided

Energy Systems Laboratory 73

Maximum Fenestration *U*-factor
(Section 402.6)

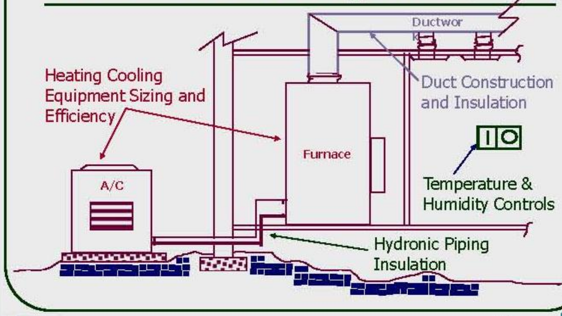
- Maximum area weighted average fenestration *U*-factor shall be 0.40
  - Using trade-offs from Section 402.1.3 or
  - Section 404 in zones 4 – 6

Energy Systems Laboratory 74

Section 403

Systems

Residential HVAC Systems *(Section 403)*



Energy Systems Laboratory 76

HVAC Efficiency Requirements

- Pre-empted by the National Appliance Energy Conservation Act (NAECA)
- Applies to heating and cooling and water heating systems

Energy Systems Laboratory 77

Controls *(Section 403.1)*

- One thermostat per system
- Heat pump supplementary heat
  - Prevent supplemental heat operation when the heat pump compressor can meet the heating load (Section 403.1.1)

Energy Systems Laboratory 78

Duct Insulation *(Section 403.2.1)*

- Supply and return ducts
  - R-8 minimum
- Ducts in floor trusses
  - R-6 minimum
- Exception
  - Ducts located completely inside the building thermal envelope
  - Supply & Return may by R-6 if the AC efficiency is upgraded 1 SEER above NAECA

SECO Energy Systems Laboratory 79

HVAC Duct Insulation

SECO Energy Systems Laboratory 80

SECO Energy Systems Laboratory 81

Leaking Ducts?

The "Achilles' heel of home energy efficiency and air quality.

- Contribute to air leakage in house
  - Returns twice as leaky as supplies
- Reduce comfort in home
  - Increase drafts
  - Unbalanced airflows reduce air delivery
- Contribute to moisture problems!
- Contribute to backdrafting
  - Leaky return depressurizes lower floors
  - Leaky supply's may depressurize upper floors
- May lead to soil gas entrainment!

SECO Energy Systems Laboratory 82

Duct Sealing *(Section 403.2.2)*

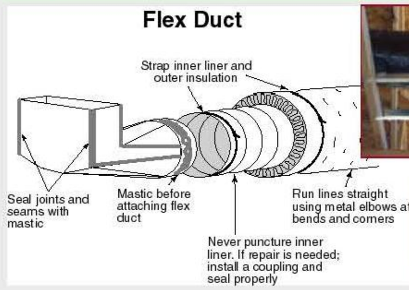
- **ALL** ducts, air handlers, filter boxes, and building cavities used as ducts must be sealed
  - Joints and seams must comply with International Residential Code Section M1601.3.1
- Building framing cavities must not be used as supply ducts *(Section 403.2.3)*

SECO Energy Systems Laboratory 83

<u>Do not</u> use DUCT TAPE!

SECO Energy Systems Laboratory 84

Proper Installation



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HVAC Duct Sealing Applications

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HVAC Duct Sealing

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HVAC Duct Sealing - NOT

SECO Energy Systems Laboratory 88

HVAC Duct Sealing- NOT

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HVAC Piping Insulation *(Section 403.3)*

- Minimum R-2
- Fluids above 105°F or below 55°F

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Circulating Service Water Heating Systems *(Section 403.4)*

- Piping insulated to minimum R-2
- Automatic or *readily accessible* manual switch on pump

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Mechanical Ventilation *(Section 403.5)*

- Outdoor air intakes and exhausts
  - Automatic or gravity
  - Close when the ventilation system is not operating

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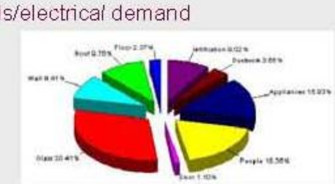
HVAC Sizing

- Reduced initial cost to builder
- Improved comfort for owner
- Better IAQ, filtration, moisture control
- Lower utility bills/electrical demand
- Less noise



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HVAC Sizing *(Section 403.6)*

- A sizing calculation is required
  - ACCA Manual J or other approved
  - *International Residential Code Section M1401.3*
- Previously just rules-of-thumb
  - Missing by miles… often 2.2-times larger
  - "Garbage-in… Garbage-out"

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Oversizing

Most A/C's (historically) are oversized for the house = resulting in short cycling

Short Cycling
- Reduces Equipment Life
- Reduces Efficiency (SEER)
- Results in Poor Dehumidification
- Reduces Filter Effectiveness

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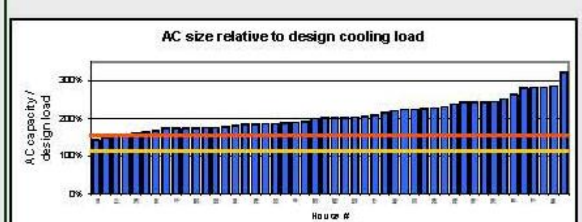
Equipment Sizing – Case Study



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(DIS)Advantages of Over-sizing
Bigger is better
An oversized unit will short cycle-times
Larger ducts, more material cost, tougher fit
Faster recovery from setback
Quick duty cycling (humidity control?)
Less worry about distribution process
Such as leaks, improper sizing
Less design time
"Rules of thumb" based on decades-old practices
A disservice to your customer
False peace of mind… There are no advantages
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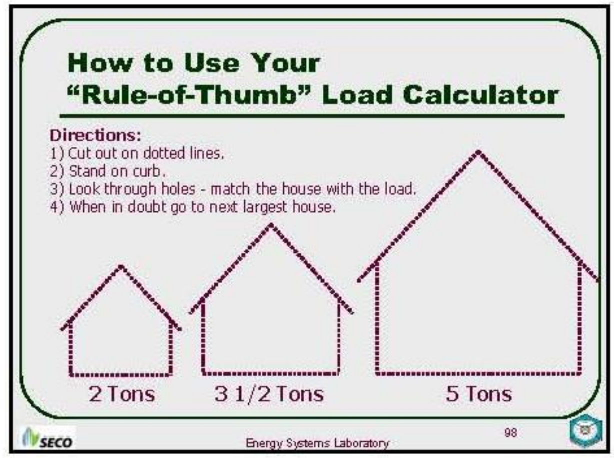
97


How to Use Your "Rule-of-Thumb" Load Calculator
Directions:
1) Cut out on dotted lines.
2) Stand on curb.
3) Look through holes - match the house with the load.
4) When in doubt go to next largest house.
2 Tons
3 1/2 Tons
5 Tons
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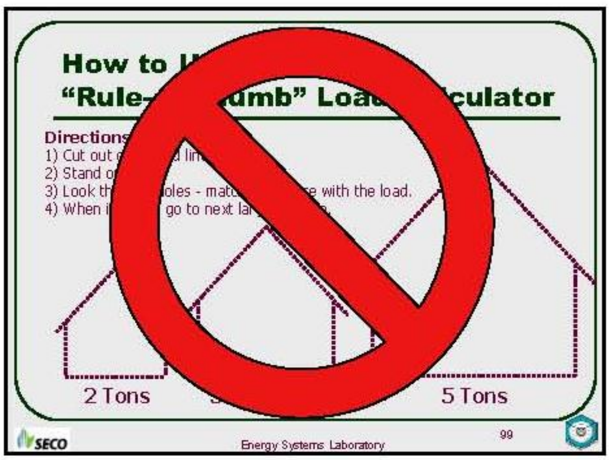
98


2 Tons
5 Tons
SECO
Energy Systems Laboratory
99


Simulated Performance Alternative (Section 404)
Analysis includes
Heating
Cooling
Service Water Heating
Mandatory requirements
Sections 401, 402.4, 402.5, 402.6, and 403
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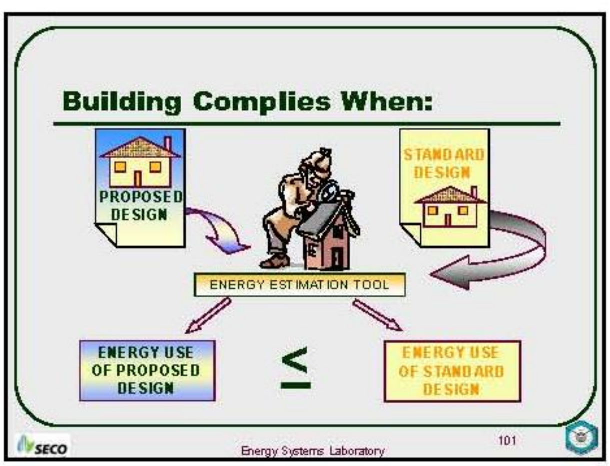
100


Building Complies When:
PROPOSED DESIGN
STANDARD DESIGN
ENERGY ESTIMATION TOOL
ENERGY USE OF PROPOSED DESIGN
≤
ENERGY USE OF STANDARD DESIGN
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101

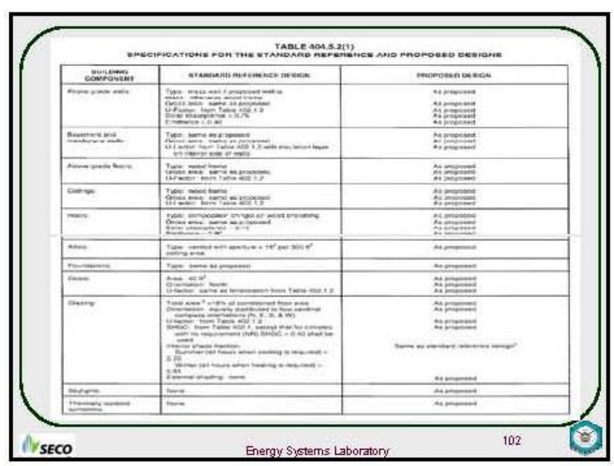
TABLE 404.5.2(1)
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS
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102

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International Code Compliance Calculator – IC3

Developed with emphasis on simplicity, ESL's goal has been to develop an easy-to-use, easy-to-access simulated performance-based tool that could be used to report reduced energy consumption to the US EPA

SECO Energy Systems Laboratory 104

IC3 International CODE COMPLIANCE CALCULATOR

International Code Compliance Calculator

- Based on the Texas Building Energy Performance Standards
- A performance-based residential energy code compliance tool
- Designed to be used in approximately 85% of new residential construction within the State of Texas

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Questions and Answers

SECO State Energy Conservation Office

IC3 International CODE COMPLIANCE CALCULATOR

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Thank you for attending!

ESL- Energy Systems Lab: http://esl.eslwin.tamu.edu/

SECO- State Energy Conservation Office:
http://www.seco.cpa.state.tx.us/
Felix Lopez, P.E.
Felix.lopez@cpa.state.tx.us

DOE- Department of Energy: http://www.energy.gov/

EPA- Environmental Protection Agency: http://www.epa.gov/

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Three Residential 2006 International Energy Conservation Code classes were held in 2009.

TITLE	LOCATION	DATE	ATTENDEES
Res - 2006 IECC	Carrollton	8/6/2009	10
Res - 2006 IECC	Amarillo	7/16/2009	15
Res - 2006 IECC	Arlington	5/18/2009	21
		TOTAL	46

Presented by Ed Dryden
July 16, 2009

IECC 2006 Residential - Amarillo

SECO

#	NAME	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	W.M. Parr		7619 Cervin Dr.	Amarillo	TX	79121	bilandmax@suddenlink.net	806-353-1331	✓
2	Frank Nelson		3210 Austin St.	Amarillo	TX	79109	frank-mj@msn.com	806-352-2966	
3	Jeff Worsham	Archstone Home Inspections	7618 Tarrytown Ave.	Amarillo	TX	79121	jeff@inspectamarillo.com	806-640-2199	✓
4	Donny Cornelius	City of Canyon	301 16th St.	Canyon	TX	79015	dcornelius@canyontx.com	806-655-5014	✓
5	Karen Hutson	City of Dimmitt	PO Box 146	Dimmitt	TX	79027	khutdim@amaonline.com	806-647-4492	
6	Dwain Sumpter	City of Childress	PO Box 1087	Childress	TX	79201			
7	Gerald Chen	West TAMU	WT Box 61267	Canyon	TX	79016	gchen@mail.wtamu.edu	806-651-2449	
8	Mike Waller	City of Amarillo		Amarillo	TX		michael.waller@amarillo.gov	806-378-6268	
9	Chuck Baker	Childress Construction Inc.	300 Commerce St.	Childress	TX	79201	cli.cbc@sbcglobal.net	806-221-2102	
10	Valdi Trammell	N &B Homes	17701 Whitewing	Canyon	TX	79015		806-290-1189	
11	Michael Green	Michael E. Green Architect	7813 Harrington	Amarillo	TX	79121	green82@nts-online.net	806-353-3970	✓
12	Amy Taylor	CRL Architect	619 S. Tyler Ste 100	Amarillo	TX	79101	ataylor@crlarchitect.com	806-374-0676	✓
13	Joe Norman	Joe Norman & Co.	PO Box 19807	Amarillo	TX	79114	jnorman@suddenlinkmail.com	806-352-6555	
14	Tommy Stafford	Greenways	6003 Tuscany Vlg.	Amarillo	TX	79109	tommys@greenwaysofamarillo.com	806-467-1000	
15	Kim Johnston	Dare to Dream Home Designs	1104 5th Ave.	Canyon	TX	79015	daretodream@ssuddenlinkmail.com	806-683-0303	

IECC 2006 Residential - BPI Arlington 5/18/2009

SECO

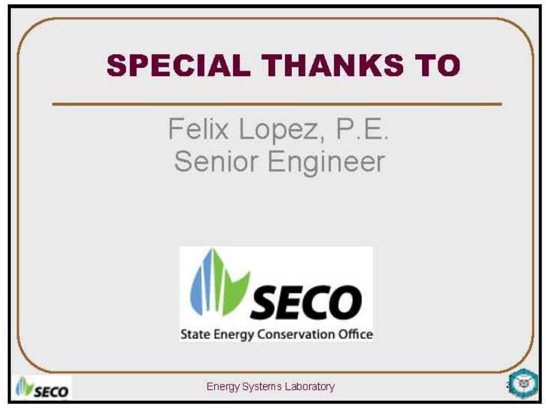
#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Bobby Benfett								
3	Norma Briceno								
6	Michael Climer								
9	Cherie Delude								
2	Mark Feighner								
4	Joseph Ferraro								
5	Mark Hickman								
7	Rhonda Johnson								
8	Tommy Jones								
10	Ward Lee								
11	Guy Lux								
12	Eddie Mitchell								
13	Cynthia Montgomery								
14	Henry Obidzienski								
15	Jeff O'Dell								
16	Julio Ruiz								
17	William Slavik								
18	Clint Sparks								
19	Chris Tucker								
20	Thomas Wood								
21	Sana Touma								

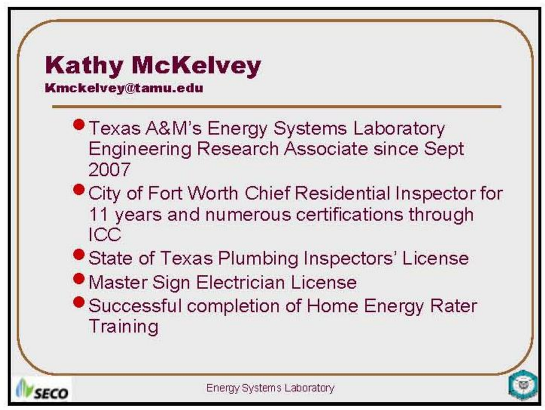
Presented by Kathy McKelvey
August 6, 2009

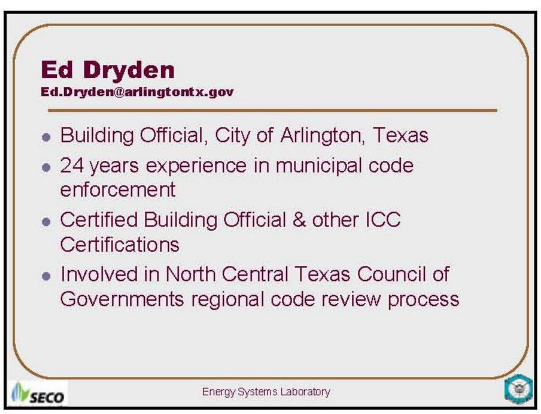
IECC 2006 Residential - Carrollton

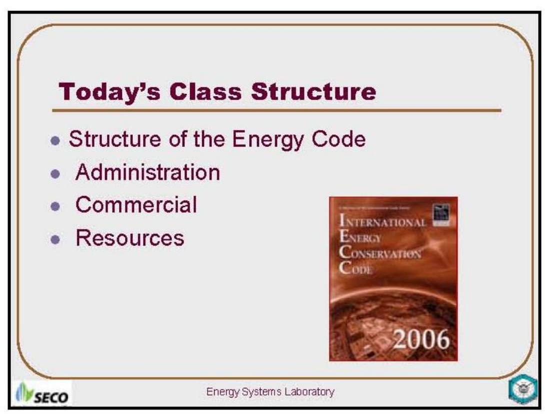
#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Billy McMahon	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	billy.mcmahon@cityofcarrollton.com	214-546-0155	✓
2	Brett King	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	brett.king@cityofcarrollton.com	972-466-3157	✓
3	Mariann Tedder	City of McKinney	221 N. Tennessee	McKinney	TX	75070	mtedder@mckinneytexas.org	972-547-7476	✓
4	Kathy Marcussen	City of McKinney	221 N. Tennessee	McKinney	TX	75070	kmarcussen@mckinneytexas.org	972-547-7446	✓
5	Jeff Harris	City of McKinney	221 N. Tennessee	McKinney	TX	75069	jharris@mckinneytexas.org	972-547-7452	✓
6	Sherry Copeland	City of Irving	825 W. Irving Blvd.	Irving	TX	75060	scopelan@cityofirving.org	972-721-4886	✓
7	Claudia Reynolds	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	claudia.reynolds@cityofcarrollton.com	972-466-3061	
8	Daniel Garcia	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	daniel.garcia@cityofcarrollton.com	972-466-3236	✓
9	Ray Hopkins	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	ray.hopkins@cityofcarrollton.com	972-466-3244	✓
10	Joelle Hainley	Town of Flower Mound	2121 Cross Timbers Rd.	Flower Mound	TX	75028	joelle.hainley@flower-mound.com	972-874-6367	✓

The 2006 Commercial Workshops include detailed instruction on chapters relating to commercial regulations and a summary of the relationship between ASHRAE 90.1-2007 and the commercial provisions of the IECC.









Structure of Energy Code

- Chapter 1 Administration
- Chapter 2 Definitions
- Chapter 3 Climate Zones
- Chapter 4 Residential Energy Efficiency
- Chapter 5 Commercial Energy Efficiency
- Chapter 6 Referenced Standards

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Texas Amendments

- North Central Texas Council of Governments Applicable Statewide
- Energy Systems Laboratory, Texas Engineering Experiment Station, Texas A&M University System

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Administration *(Section 101.4)*

- Establishes minimum regulations
  - Detached One- and Two-family
  - Type R-2, R-4 or Townhouse buildings
  - Commercial and High-Rise Multifamily
- Regulates design and selection of
  - Building envelope
  - Mechanical systems
  - Service water heating systems
  - Electrical power and lighting systems

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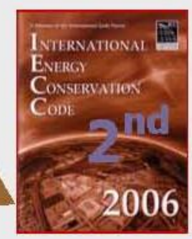
Precedence *(Section 101.3)*

1st



2nd

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Scope: Residential *(Section 202)*
(What types of buildings covered?)

Detached One- and Two-family Dwellings

R-2, R-3, R-4, Low-Rise Multi-family ≤3 stories

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Scope: Commercial *(Section 202)*
(What types of buildings covered?)

All buildings that are not included as Residential

Such as:

- Retail, grocery and wholesale stores
- Offices
- Restaurants
- Assembly & conference
- Institutional, hospital or jail
- Industrial work buildings
- Schools and churches
- Theaters
- Hotels and motels

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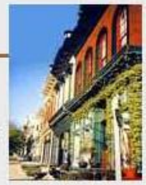
Scope *(Section 101.4)*



- New construction *(Section 101.2)*
- Existing buildings *(Section 101.4.1)*
- Historic buildings *(Section 101.4.2)*
- Additions *(Section 101.4.3)*
- Change in Occupancy *(Section 101.4.4)*
- Mixed occupancy *(Section 101.4.5)*

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Historic *(TX Section 101.4.2)*

- Buildings officially identified as
  - Listed in the State or National Register of Historic Places
  - Designated under local or state designation law
  - Certified as a contributing resource in a designated historic district
  - Certification that the property is eligible to be listed, individually or as a contributing building
    - State Historic Preservation Officer
    - Keeper of the National Register of Historic Places
- shall comply with all of the provisions of this code.

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Exception

- Whenever a provision or provisions shall invalidate or jeopardize the historical designation or listing, that provision or provisions may be exempted.

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Additions, Alterations, Renovations or Repairs *(Section 101.4.3)*

- Applies as it relates to new construction
- Without requiring the unaltered portion to comply
- Exceptions

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Exceptions

- Storm windows over existing fenestration
- Glass only replacements in an existing sash and frame
- Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation
- Construction were the existing roof, wall or floor cavity is not exposed

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Change in Occupancy *(Section 101.4.4)*

- Change would result in an increase in
  - Fossil fuel demand, OR
  - Electrical energy use

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Low Energy Use Buildings *(Section 101.5.2)*

The following are exempt

- <3.4 Btu/h-ft^2 or 1 Watt/ft^2 of floor area
- Do not contain conditioned space

Note: Exempt from the building thermal envelope provisions only

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Material Identification *(Section 102.1)*

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Fenestration Product Rating

- Testing Standards
  (Section 102.1.3)
  - *U*-factors – NFRC 100 or Table 102.1.3(1) or 102.1.3(2)
  - SHGC – NFRC 200 or Table 102.1.3(3)

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Alternative Compliance
(TX Section 103.3.1.1)

- A building certified by a national, state, or local accredited energy efficiency program and determined by the Energy Systems Laboratory to be in compliance with the energy efficiency requirements of this section may, at the option of the Code Official, be considered in compliance. The United States Environmental Protection Agency's Energy Star Program certification of energy code equivalency shall be considered in compliance
- This amendment is added to allow alternative compliance in accordance with Texas HB 1365, 78th Legislature

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Maintenance Information *(Section 102.3)*

- Instructions for building owner
  - **Preventative maintenance instructions**
    - Equipment and Systems
    - Clearly stated and incorporated on a readily accessible label
      - Including the title or publication number for the operation and maintenance manual for that particular model and type of product

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Construction Documents *(Section 104.2)*

At a minimum, this information should appear on the construction documents:

- Show sufficient detail on plans/specifications to indicate conformance with energy requirements
- EXAMPLES:
  - Fenestration *U*-factors
  - Duct insulation levels
  - Envelope insulation levels (*R*-values)
  - Air sealing techniques (caulk & seal vs. wrap)
  - High efficiency heating/cooling equipment

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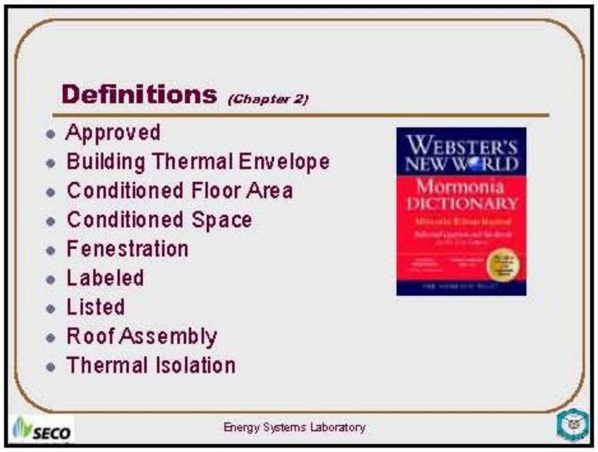

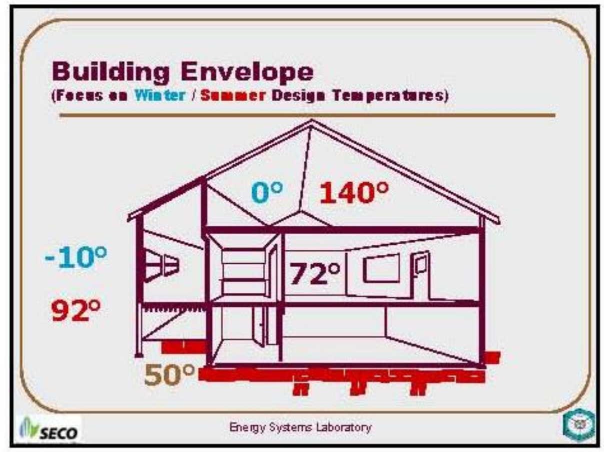

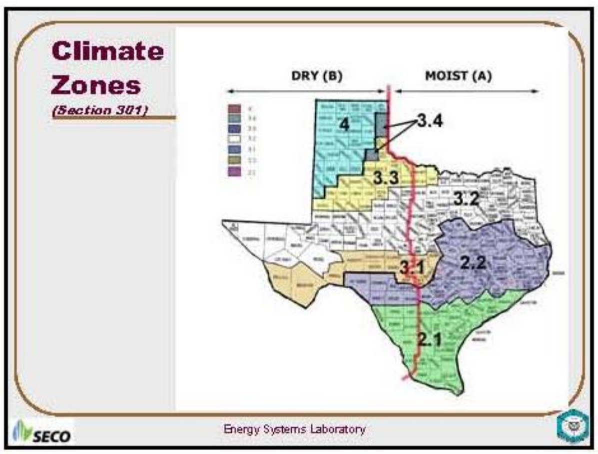

TABLE 301.1(1) CLIMATE ZONES AND SUB CLIMATE ZONES FOR TEXAS
Zone 2

ANDERSON	2.2	DE WITT	2.1	JIM HOGG	2.1	ORANGE	2.2
ANGELINA	2.2	DIMMIT	2.1	JIM WELLS	2.1	POLK	2.2
ARANSAS	2.1	DUVAL	2.1	KARNES	2.1	REAL	2.2
ATASCOSA	2.1	EDWARDS	2.2	KENEDY	2.1	REFUGIO	2.1
AUSTIN	2.2	FALLS	2.2	KINNEY	2.2	ROBERTSON	2.2
BANDERA	2.2	FAYETTE	2.2	KLEBERG	2.1	SAN JACINTO	2.2
BASTROP	2.2	FORT BEND	2.2	LA SALLE	2.1	SAN PATRICIO	2.1
BEE	2.1	FREESTONE	2.2	LAVACA	2.2	STARR	2.1
BELL	2.2	FRIO	2.1	LEE	2.2	TRAVIS	2.2
BEXAR	2.2	GALVESTON	2.1	LEON	2.2	TRINITY	2.2
BOSQUE	2.2	GOLIAD	2.1	LIBERTY	2.2	TYLER	2.2
BRAZORIA	2.1	GONZALES	2.2	LIMESTONE	2.2	UVALDE	2.2
BRAZOS	2.2	GRIMES	2.2	LIVE OAK	2.1	VAL VERDE	2.2
BROOKS	2.1	GUADALUPE	2.2	MADISON	2.2	VICTORIA	2.1
BURLESON	2.2	HARDIN	2.2	MATAGORDA	2.1	WALKER	2.2
CALDWELL	2.2	HARRIS	2.2	MAVERICK	2.1	WALLER	2.2
CALHOUN	2.1	HAYS	2.2	MCLENNAN	2.2	WASHINGTON	2.2
CAMERON	2.1	HIDALGO	2.1	MCMULLEN	2.1	WEBB	2.1
CHAMBERS	2.2	HILL	2.2	MEDINA	2.2	WHARTON	2.1
CHEROKEE	2.2	HOUSTON	2.2	MILAM	2.2	WILLACY	2.1
COLORADO	2.2	JACKSON	2.1	MONTGOMERY	2.2	WILLIAMSON	2.2
COMAL	2.2	JASPER	2.2	NEWTON	2.2	WILSON	2.2
CORYELL	2.2	JEFFERSON	2.2	NUECES	2.1	ZAPATA	2.1

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Zone 3

ANDREWS	3.2	EL PASO	3.2	KERR	3.1	ROCKWALL	3.2
ARCHER	3.3	ELLIS	3.2	KIMBLE	3.1	RUNNELS	3.2
BAYLOR	3.3	ERATH	3.2	KING	3.3	RUSK	3.2
BLANCO	3.1	FANNIN	3.2	KNOX	3.3	SABINE	3.2
BORDEN	3.3	FISHER	3.2	LAMAR	3.2	SAN AUGUSTINE	3.2
BOWIE	3.2	FOARD	3.3	LAMPASAS	3.2	SAN SABA	3.2
BREWSTER	3.1	FRANKLIN	3.2	LLANO	3.1	SCHLEICHER	3.1
BROWN	3.2	GAINES	3.3	LOVING	3.2	SCURRY	3.3
BURNET	3.1	GARZA	3.3	LUBBOCK	3.3	SHACKELFORD	3.2
CALLAHAN	3.2	GILLESPIE	3.1	LYNN	3.3	SHELBY	3.2
CAMP	3.2	GLASSCOCK	3.2	MARION	3.2	SMITH	3.2
CASS	3.2	GRAYSON	3.2	MARTIN	3.2	SOMERVELL	3.2
CHILDRESS	3.3	GREGG	3.2	MASON	3.1	STEPHENS	3.2
CLAY	3.3	HALL	3.4	MCCULLOCH	3.2	STERLING	3.2
COKE	3.2	HAMILTON	3.2	MENARD	3.1	STONEWALL	3.3
COLEMAN	3.2	HARDEMAN	3.3	MIDLAND	3.2	SUTTON	3.1
COLLIN	3.2	HARRISON	3.2	MILLS	3.2	TARRANT	3.2
COLLINGSWORTH	3.3	HASKELL	3.2	MITCHELL	3.2	TAYLOR	3.2
COMANCHE	3.2	HEMPHILL	3.4	MONTAGUE	3.2	TERRELL	3.1
CONCHO	3.2	HENDERSON	3.2	MORRIS	3.2	TERRY	3.3
COOKE	3.2	HOOD	3.2	MOTLEY	3.3	THROCKMORTON	3.2
COTTLE	3.3	HOPKINS	3.2	NACOGDOCHES	3.2	TITUS	3.2
CRANE	3.2	HOWARD	3.2	NAVARRO	3.2	TOM GREEN	3.2
CROCKETT	3.1	HUDSPETH	3.2	NOLAN	3.2	UPSHUR	3.2
CROSBY	3.3	HUNT	3.2	PALO PINTO	3.2	UPTON	3.2
CULBERSON	3.2	IRION	3.2	PANOLA	3.2	VAN ZANDT	3.2
DALLAS	3.2	JACK	3.2	PARKER	3.2	WARD	3.2

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Zone 3 Con't.

DAWSON	3.3	JEFF DAVIS	3.2	PECOS	3.2	WHEELER	3.4
DELTA	3.2	JOHNSON	3.2	PRESIDIO	3.1	WICHITA	3.3
DENTON	3.2	JONES	3.2	RAINS	3.2	WILBARGER	3.3
DICKENS	3.3	KAUFMAN	3.2	REAGAN	3.2	WINKLER	3.2
EASTLAND	3.2	KENDALL	3.1	RED RIVER	3.2	WISE	3.2
ECTOR	3.2	KENT	3.3	REEVES	3.2	WOOD	3.2
						YOUNG	3.2

Zone 4

ARMSTRONG	DEAF SMITH	HOCKLEY	PARMER
BAILEY	DONLEY	HUTCHINSON	POTTER
BRISCOE	FLOYD	LAMB	RANDALL
CARSON	GRAY	LIPSCOMB	ROBERTS
CASTRO	HALE	MOORE	SHERMAN
COCHRAN	HANSFORD	OCHILTREE	SWISHER
DALLAM	HARTLEY	OLDHAM	YOAKUM

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Chapter 8

Building Design for All Commercial Buildings

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What is ASHRAE 90.1?

- ASHRAE/IESNA Standard 90.1, *Energy Standard for Buildings Except for Low-Rise Residential Buildings*
- Standard of stringency established by Energy Policy Act 1992

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Structure of 90.1

- Section 1 Purpose
- Section 2 Scope
- Section 3 Definitions, Abbreviations, and Acronyms
- Section 4 Administration and Enforcement
- Section 5 Building Envelope
- Section 6 Heating, Ventilating, and Air-Conditioning
- Section 7 Service Water Heating
- Section 8 Power
- Section 9 Lighting
- Section 10 Other Equipment
- Section 11 Energy Cost Budget Method

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Structure of 90.1- Appendix

- Appendix A Rated R-Value of Insulation and Assembly U-factor, C-factor and F-factor determinations
- Appendix B Building Envelope Criteria
- Appendix C Methodology for Building Trade-off option in Subsection 5.6
- Appendix D Climate Data
- Appendix E Informative References
- Appendix F Addenda Description Information
- Appendix G Performance Rating Method

Energy Systems Laboratory

Structure of 90.1

- X.1 General
- X.2 Compliance Paths
- X.3 Simplified Approach Options
- X.4 Mandatory Provisions
- X.5 Prescriptive Options
- X.6 Trade-Off Option
- X.7 Submittals
- X.8 Product Information and Installation Requirements

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Compliance Software *(TX Section 501.3)*

- Tools used to demonstrate energy code compliance that are deemed acceptable may only utilize the energy chapter of the 2006 IECC or ASHRAE 90.1-2004 when code edition and/or standard selection is available.
- COMcheck is an acceptable software tool for commercial code compliance in Texas.

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Building Envelope Requirements

(Section 502.1)

- For buildings ≤40% glazing to gross wall area of above-grade walls
- All components must meet or exceed building envelope requirements
  - Tables 502.2(1) – 502.3
- Based on
  - Climate zone
  - Framing type
  - Construction assembly

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Opaque Doors *(Section 502.2.7)*

Doors

- Less than 50% glass area
- Meet *U*-factor requirement for doors in Table 502.2(1)
- Considered part of the gross area of above-grade walls that are part of the building envelope

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Fenestration *(Section 502.3)*

- Not exceed percentage of gross wall area specified in Table 502.3
- Requirements based on projection factor
  - Maximum *U*-factor
  - SHGC

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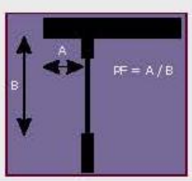
Projection Factor *(Section 502.2.3)*

Where different windows or glass doors have different PF values, they must be evaluated separately, or an area-weighted average must be used for all



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Projection Factor - A

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Projection Factor - B

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Skylights *(Section 502.3.2)*

- Restricted to <3% of roof area
- Requirements based on
  - *U*-factor
  - SHGC
  - Glass or Plastic

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Air Leakage *(Section 502.4.1)*

Manufactured window and door air leakage rates

- Labeled windows and doors enforced at point of manufacturer *(AAMA/WDMA 101/I.S.2)*
- Exception
  - Site constructed windows/doors to be caulked, casketed, weatherstripped

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Commercial Entrance Doors
(Section 502.4.2)

- Includes curtain wall and storefront glazing
- Tested for air leakage at 1.57 psi per ASTM E 283

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Seal the Building Envelope
(Section 502.4.3)

- Openings and penetrations shall be sealed with caulking or closed with gaskets compatible with the construction materials and location
- Joints and seams shall be sealed, taped, or covered with a moisture vapor-permeable wrapping material
- Sealing shall allow for expansion and contraction of the materials

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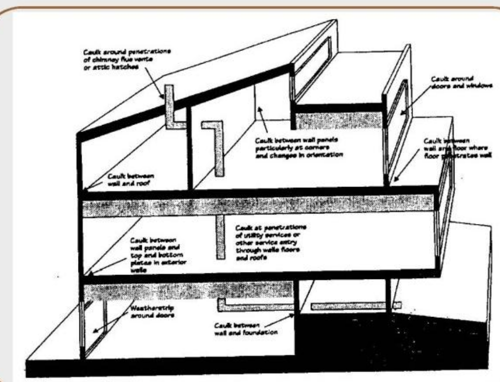

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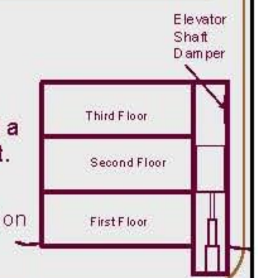
Outdoor air intakes and exhaust openings *(Section 502.4.4)*

- Class I dampers required
  - Stairs
  - Elevator shafts
  - Other dampers
- Motorized, leakage-rated at a maximum of 4 cfm per sq. ft.
- Exception
  - Gravity dampers permitted on buildings <3 stories above grade



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Loading Dock Weatherseals

(Section 502.4.5)

- Equip cargo doors and loading dock doors with weatherseals
- Restrict infiltration

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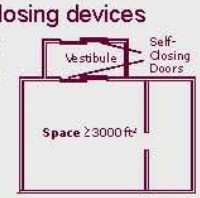
Vestibules *(Section 502.4.6)*

- A door that separates conditioned space from the exterior must be protected with an enclosed vestibule
- All doors *must* have self-closing devices
- Interior and exterior doors not required to be open at the same time



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Exceptions *(Section 502.4.6)*

- Buildings in Climate Zones 1 and 2
- Doors not intended to be used as building entrance
- Doors from sleeping or dwelling unit
- Space less than 3,000 sq. ft.
- Revolving doors
- Doors used primarily for vehicular movement, material handling and adjacent personnel doors
- Doors in buildings < 4 stories above grade

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Vestibules

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Recessed Lighting *(Section 502.4.7)*

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Moisture Control *(Section 502.5)*

Vapor Retarders must be provided

- Install in nonvented framed ceilings, walls, floors
- Must have a Perm Rating of <1.0
- “warm-in-winter” side of insulation

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Moisture Control *(Section 502.5)*

Exceptions

- Buildings located in Climate Zones 1 through 3
- Where moisture or its freezing will not damage the materials
- Where other approved means to avoid condensation in unventilated framed wall, floor, roof and ceiling cavities are provided

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Section 503

Building Mechanical Systems

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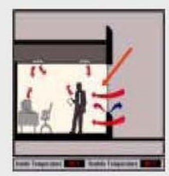
HVAC Load Calculations *(Section 503.2.1)*

Designers must perform heating and cooling load calculations before selecting HVAC equipment

- ASHRAE *Handbook of Fundamentals* ***2004***

or

- approved equivalent computation procedure



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Equipment Sizing *(Section 503.2.1.1)*

- Not to exceed the loads calculated
- Simple Systems with a single piece of equipment
  - Select system for greatest load (either heating or cooling), select other capacity as small as possible
- Exceptions
  - Standby equipment with required controls that allow operation only when primary equipment is not operating
  - Multiple units with combined capacities exceeding loads
    - Sequencing controls required

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Equipment Efficiency *(Sections 503.2.3)*

- Efficiency requirements listed in Tables 503.2.3 (1) – (11)
- Must meet full- and part-load values

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Equipment Efficiency - Example

TABLE [illegible]
WATER CHILLING PACKAGES, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	MINIMUM EFFICIENCY	TEST PROCEDURE
Air cooled, with condenser, Electrically operated	< 150 tons	2.80 COP 2.80 IPLV	
	≥ 150 tons	2.50 COP 2.50 IPLV	
Air cooled, without condenser, Electrically operated	All capacities	3.10 COP 3.10 IPLV	
Water cooled, Electrically operated, Positive displacement (reciprocating)	All capacities	4.20 COP 4.65 IPLV	
Water cooled, Electrically operated, Positive displacement (rotary screw and scroll)	< 150 tons	4.45 COP 4.50 IPLV	ARI 550/590
	≥ 150 tons and < 300 tons	4.90 COP 4.95 IPLV	
	≥ 300 tons	5.50 COP 5.60 IPLV	
Water cooled, Electrically operated, centrifugal	< 150 tons	5.00 COP 5.00 IPLV	
	≥ 150 tons and < 300 tons	5.55 COP 5.55 IPLV	
	≥ 300 tons	6.10 COP 6.20 IPLV	
Air cooled, absorption single effect	All capacities	0.60 COP	ARI 560
Water cooled, absorption single effect	All capacities	0.70 COP	
Absorption double effect, indirect-fired	All capacities	1.00 COP 1.05 IPLV	
Absorption double effect, direct-fired	All capacities	1.00 COP 1.00 IPLV	

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Temperature Controls *(Section 503.2.4.1)*

- Each heating and cooling system must be controlled by
  - Solid-state programmable thermostat
  - Capability to setback or shut down
    - Time of day and day of week
    - Manual override

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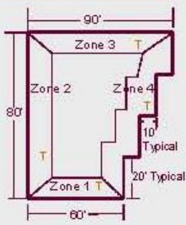
Exception

- Perimeter system zoning allowed
  - One zone for each major exposure having an exterior wall that only one direction for more than 50 contiguous feet and
  - Perimeter zone is controlled by a thermostat(s) located in the zones served



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Humidity Controls *(Section 503.2.4.1)*

Capacity to prevent use of fossil fuel or electric power to achieve humidity <60% in cooling mode and >30% in heating mode

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Heat Pump Supplementary Heat
(Section 503.2.4.1.1)

- Controls to prevent supplemental heat operation when the heat pump can meet the heating load
  - Except during defrost

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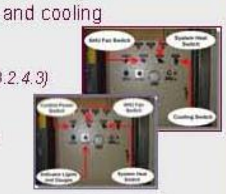
HVAC System Controls

- Set Point Overlap Restriction *(Section 503.2.4.2)*
  - Where used to control heating and cooling
  - Deadband of at least 5°F
- Off-hour Controls *(Section 503.2.4.3)*
  - Automatic time clock
  - Programmable control system
  - Exceptions
    - Zones operated continuously
    - Full HVAC load demand not exceeding 6,800 Btu/h (2kW) with a readily accessible manual shut off switch



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Shutoff Dampers *(Section 503.2.4.4)*

- Motorized required for outdoor-air-supply and exhaust systems
- Exceptions
  - Gravity dampers are permitted
    - In buildings less than 3 stories in height
    - Permitted in Climate zones 1, 2, 3
    - With airflows of 300 cfm or less

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Ventilation *(Section 503.2.5)*

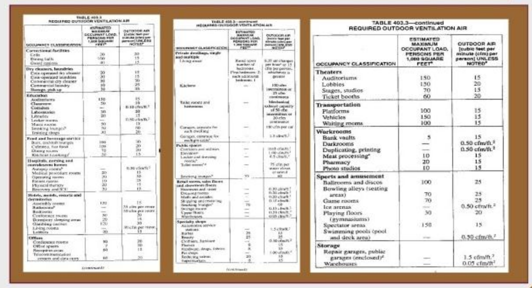

TABLE 403.3—continued
REQUIRED OUTDOOR VENTILATION AIR

OCCUPANCY CLASSIFICATION	ESTIMATED MAXIMUM OCCUPANT LOAD, PERSONS PER 1,000 SQUARE FEET[a]	OUTDOOR AIR [cubic feet per minute (cfm) per person] UNLESS NOTED[e]
Theaters		
Auditoriums	150	15
Lobbies	150	20
Stages, studios	70	15
Ticket booths	60	20
Transportation		
Platforms	100	15
Vehicles	150	15
Waiting rooms	100	15
Workrooms		
Bank vaults	5	15
Darkrooms	—	0.50 cfm/ft.[2]
Duplicating, printing	—	0.50 cfm/ft.[2]
Meat processing[c]	10	15
Pharmacy	20	15
Photo studios	10	15
Sports and amusement		
Ballrooms and discos	100	25
Bowling alleys (seating areas)	70	25
Game rooms	70	25
Ice arenas	—	0.50 cfm/ft.[2]
Playing floors (gymnasiums)	30	20
Spectator areas	150	15
Swimming pools (pool and deck area)	—	0.50 cfm/ft.[2]
Storage		
Repair garages, public garages (enclosed)[d]	—	1.5 cfm/ft.[2]
Warehouses	—	0.05 cfm/ft[2]

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Energy Recovery Ventilation Systems *(Section 503.2.6)*

- Required on individual fan systems that
  - A design supply air capacity of 5000 cfm or greater; and
  - A minimum outside air supply of 70% or greater of the design supply
- Provides a change in the enthalpy of the outdoor air of 50% or more of the difference between the outdoor air and the return air at design conditions
- Exceptions

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Duct Systems

Duct systems are defined as a continuous passageway for the transmission of air that includes

- Ducts
- Duct fittings
- Dampers
- Plenums
- Fans, and
- Accessory air-handling equipment and appliances

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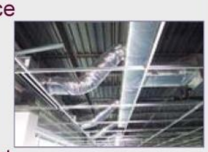
Duct Insulation *(Section 503.2.7)*

- Required for supply and return ducts
  - Located in unconditioned space
    R5
  - Located outside the building
    R8
- Exceptions
  - When located within equipment
  - Wing the design temperature between the interior and exterior of the duct or plenum does not exceed 15°F



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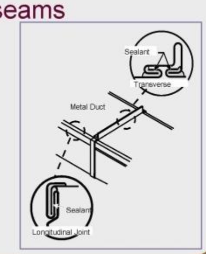
Duct Sealing *(Section 503.2.7)*

Seal and securely fasten **all** joints, longitudinal and transverse seams and connections with

- welds
- mastic-plus-embedded fabric system
- mastics
- gaskets
- approved tapes



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HVAC Piping Insulation *(Section 503.2.8)*

Piping serving as part of heating or cooling system must be insulated in accordance with Table 503.3.8

FLUID	Nominal Pipe Diameter	
	≤1.5"	>1.5"
Steam	1.5	3.0
Hot Water	1.0	2.0
Chilled water, brine or refrigerant	1.0	1.5

a. Insulation K value <.27 Btu per inch/h·ft²

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HVAC System Completion *(Section 503.2.9)*

- Air System Balancing *(Section 503.3.9.1)*
  - Supply air outlets and zone terminal devices must have means to air balance
  - Discharge dampers prohibited on constant volume and variable volume fans with motors >25 hp
- Hydronic Systems *(Section 503.3.9.2)*
  - Individual hydronic heating and cooling coils to be equipped with means for balancing and pressure test connections

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Manuals *(Section 503.3.9.3)*

Operating & Maintenance Manual required

Contents

- Equipment capacity and required maintenance
- Equipment O & M Manuals
- HVAC system control maintenance and calibration information
- Written narrative of each system operation

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Simple HVAC Systems *(Section 503.3)*

Unitary or packaged, single zone controlled by a single thermostat in the zone served. Also applies to two-pipe heating systems serving one or more zones, where no cooling system is installed. Includes:

- Unitary Air Conditioners and Condensing Units
- Unitary and Applied Heat Pumps, Electrically Operated
- Packaged Terminal Air Conditioners
- Packaged Terminal Heat Pumps
- Warm Air Furnaces
- Warm Air Duct Furnaces
- Unit Heaters

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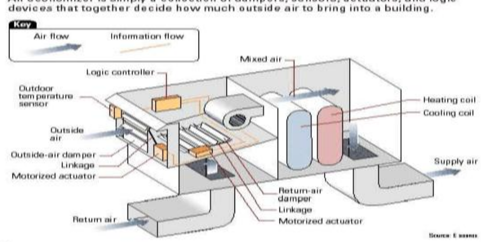
Economizers

Figure 1: The components of an economizer

An economizer is simply a collection of dampers, sensors, actuators, and logic devices that together decide how much outside air to bring into a building.



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Economizers *(Section 503.3.1)*

- Where required by Table 503.3.1(1)
- Exceptions
  - Efficiency meets requirements in Table 503.2.3(1) or 503.2.3(2)
  - Systems with air or evaporatively cooled condensers and that serve spaces with open case refrigeration or that require filtration equipment in order to meet the minimum ventilation requirements

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Hydronic System Controls
(Section 503.3.2)

Limit reheat/recool of fluids
- Single boilers >300,000 Btu/h
- Must meet the requirements of Section 503.4.3

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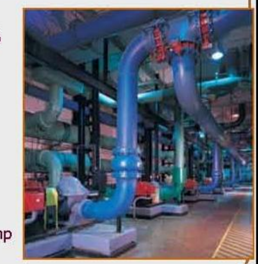
Complex HVAC Systems *(Section 503.4)*

All systems not covered under Simple HVAC Systems

Includes:
- Systems serving multiple zones
- Water chilling packages
- Variable Air Volume (VAV) Systems
- Two-pipe Changeover
- Four-pipe Systems
- Hydronic (water loop) heat pump systems



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Economizers *(Section 503.4.1)*

- Required in accordance with Table 503.3.1
- Exceptions
  - Water economizers
    - Direct and/or indirect evaporation
    - Provide 100% of cooling load
      - 50^0F dry bulb/40^0F wet bulb and below
  - Systems that meet the minimum efficiency requirements and exceed the minimum EER or the integrated part load value (IPLV) as required in Table 503.3.1(2)

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Variable Air Volume Fan Control
(Section 503.4.2)

Individual VAV fan motors $\geq$10 Hp (7.5 kW)
- Driven by mechanical or electrical variable speed drive,

or

- Have controls or devices resulting in a fan motor demand $\leq$50% of the design wattage at 50% of design airflow when static pressure set point = 1/3 of the total design static pressure

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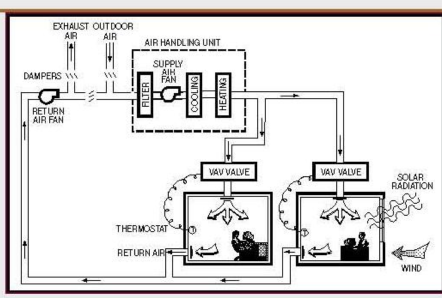
Variable Air Volume



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Hydronic System Controls *(Section 503.4.2)*

Limit reheat/recool of fluids
- Multiple-packaged boiler systems
  - Designed to deliver conditioned water or steam into common distribution system
  - Automatic controls capable of sequencing operation of the boilers
- Single boilers >500,000 Btu/h
  - Multistaged or modulating burner
- Three-pipe systems prohibited
  (Section 503.4.3.1)

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Two-Pipe Changeover System
(Section 503.4.3.2)

- Dead band of ≥15°F outside air temperature required between changeover from heating mode to cooling (or cooling mode to heating)
- Be designed to and provided with controls to allow operation of at least 4 hours in one mode before changing over
- Be provided with controls to allow heating and cooling supply temperatures to be no more than 30°F at changeover point

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Hydronic (water loop) Heat Pump Systems *(Section 503.4.3.3)*

Heat pumps connected to heat pump water loop with heat rejection and heat addition

- Controls capable of providing 20°F dead band between initiation of heat rejection and heat addition
- Dependent of type of cooling tower
  - Close or open circuit tower
  - Climate zones 3-8 special control requirements for closed-circuit cooling towers
- Exception
  - If a loop system temperature optimization controller is installed to determine the most efficient operating temperature based on real time conditions

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Part Load Controls *(Section 503.4.3.4)*

System ≥300,000 Btu/h

- Automatic resets for supply water temperature by at least 25% of design supply-to-return temperature differences, **or**
- Reduce system pump flow by 50% of design flow using
  - Multiple staged pumps
  - Adjustable speed drives
  - Control valves with modulate or step down capabilities
  - Other approved means

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Pump Isolation *(Section 503.4.3.5)*

- Chilled water plants with multiple chillers
  - Capacity to reduce flow automatically when a chiller is down
  - Chillers piped in a series for the purpose of increased temperature differential, shall be consider one chiller
- Boiler plants with multiple boilers
  - Capacity to reduce flow automatically when a boiler is down

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Heat Rejection Equipment
(Section 503.4.4)

Fan Motors ≥7½ HP

- Capability to operate fan at two-thirds of full speed or less, **and**
- Controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of heat rejection device
- Exception
  - Factory installed heat rejection devices within HVAC equipment meeting equipment efficiency requirements

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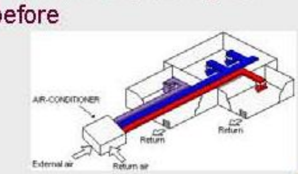
Multiple Zone Systems *(Section 503.4.5)*

- Systems serving multiple zones must be Variable Air Volume (VAV)
- Controls required to reduce primary air to each space before
  - Reheating
  - Recooling
  - Mixing



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Multiple Zone Systems *(Section 503.4.5)*

Primary air supply must reduced by one of the following

- 30% of maximum supply air
- $\le$300 cfm where maximum flow rate is <10% of total fan system supply airflow rate
- Minimum ventilation requirements of the IMC

Exceptions

6 exceptions listed

Energy Systems Laboratory

Heat Recovery for Service Water Heating *(Section 503.4.6)*

Condenser heat recovery required for heating or reheating service hot water where

- Facility operates 24 hours a day, and
- Total installed heat capacity of water cooled systems >6,000,000 Btu/hr of heat rejection, and
- Design service water heating load exceed 1,000,000 Btu/h

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Section 804

Service Water Heating

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Equipment Performance Efficiency *(Section 504.2)*

- Meet the requirements of Table 504.2

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Temperature Controls *(Section 504.3)*

- Summary of Requirements
  - Set Points
    - Dwelling unit equipment - 110^{0}F
    - Other occupancies equipment - 90^{0}F
  - Outlet temperature
    - Public rest room lavatories - 110^{0}F

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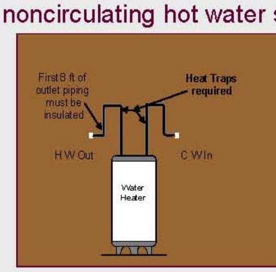
Heat Traps *(Section 504.4)*

Required on noncirculating hot water systems



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Pipe Insulation *(Section 504.5)*

- Circulating systems
  - 1” of insulation on piping
  - R-3.5/inch minimum
- Noncirculating systems
  - without integral heat traps
    - 1/2” for first 8 feet
    - R-3.5/inch minimum

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Hot Water System Controls
(Section 504.6)

Automatic circulating hot water systems and heat trace

Turned off automatically or manually when the system is not in operation

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Pool Heaters *(Section 504.7.1)*

- Pool Heaters
  - Readily accessible On/Off switch on heater
    - Not the thermostat
  - Natural gas heaters shall not have continuously burning pilot lights

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Pool Time Switches *(Section 504.7.2)*

Time switches

- All – Heated and Unheated
  - Time clocks for circulation pumps according to a preset schedule
    - Exception
      - Where 24 hour operation is required for public health standards
      - Where pumps are required to operate solar and waste-heat recovery pool heating systems

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Pool Covers *(Section 504.7.3)*

- Pool Covers
  - Required on heated pools
    - 90⁰F requires R-12 minimum
  - Vapor retardant, on or at the pool surface
  - Exception
    - 60% of the energy for heating is from site-recovered or site-solar energy

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Section 805

Lighting and Power Systems

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Interior Lighting Controls
(Section 505.2.1)

- Lighting controls required for each area enclosed by ceiling height partitions
- Switch locations
  - In view of lights
  - “On” or “off” indication from remote location

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Additional Interior Lighting Controls *(TX Section 505.2.1)*

- Each device shall control
  - A maximum of 2,500 sq. ft. for a space of 10,000 sq. ft. or less; and
  - A maximum of 10,000 sq. ft. for a space greater than 10,000 sq. ft.
- Exceptions
  - Emergency/Security Lighting
  - Egress stairway or corridor lighting

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Light Reduction Controls
(Section 505.2.2.1)

Area requires additional control to reduce lighting load by at least 50%
- Controlling all lamps or luminaries
- Reasonably uniform pattern
  - Dual switching of alternate rows of luminaries, alternate luminaries or lamps
  - Switching the middle lamp luminaries independently of the outer lamps
- Switching each luminaries or lamp

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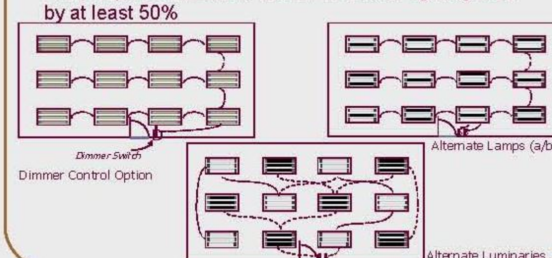
Light Reduction Controls
(Section 505.2.2.1)

Area requires additional control to reduce lighting load by at least 50%



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Exceptions

- Areas with 1 luminaire
- Areas with occupant-sensing device
- Sleeping unit
- Corridors, storerooms, restrooms, public lobbies
- Spaces with less than 0.6 watts per sq. ft.

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Automatic Lighting Shutoff
(Section 505.2.2.2)

- Buildings larger than 5,000 ft^2
  - Scheduled basis to control areas $\leq$25,000 ft^2 or no more than one floor
  - An occupant sensor that turn lighting off with 30 minutes of vacancy of space
  - A signal from another control or alarm system that indicates the area is unoccupied

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Exceptions

- Sleeping unit
- Lighting in spaces where patient care is directly provided
- Spaces where an automatic shutoff would endanger occupant safety or security

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Occupant Override *(Section 505.2.2.2.1)*

- When an automatic time switch control device is installed an override device is required
  - Readily accessible
  - Located in view of the light or the area controlled
  - Manually operated
  - Allows the lighting to remain on for ≤ 2 hours
  - Controls an area ≤ 5,000 sq. ft.

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Exceptions
Override Switch Control Device

- Time may exceed 2 hours, where captive-key override is utilized
  - Malls and arcades
  - Auditoriums
  - Single-tenant retail spaces
  - Industrial facilities
  - Arenas
- Area controlled may not exceed 20,000 sq. ft.
  - Malls and arcades
  - Auditoriums
  - Single-tenant retail spaces
  - Industrial facilities
  - Arenas

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Holiday Scheduling *(Section 505.2.2.2.2)*

- Holiday scheduling shall be incorporated in an automatic time switch device
  - Turns off all loads for at least 24 hours
  - Resumes normally scheduled operation
- Exception
  - Retail stores and associated malls
  - Restaurants
  - Grocery stores
  - Places of religious worship
  - Theaters

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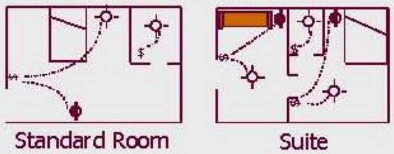
Sleeping Unit *(Section 505.2.3)*

Master switch required at entry



Standard Room

Suite

Control all permanently wired luminaries and switched receptacles, except the bathroom

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Exterior Lighting Controls
(Section 505.2.4)

Turn lights off during daylight hours or when not required during nighttime hours

- Photo Cell
- Automatic Time Switches
  - Seven Day/Seasonal Daylight Program
  - 10 hour Minimum Backup

- Exception
  - Covered vehicle entrances or exits from buildings where required for safety, security or eye adaptation

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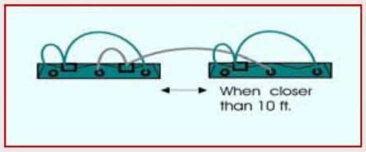
Tandem Wiring *(Section 505.3)*



- Exceptions
  - Luminaries with electronic high-frequency ballasts
  - Luminaries on emergency circuits
  - Luminaries with no available pair in the same area

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Exit Signs *(Section 505.4)*

Internally illuminated exit signs shall not exceed 5 Watts per side

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Does the Building Comply?

- Determine the total connected power in watts for the proposed lighting
- Determine the interior lighting power budget for the entire building or space
- Building complies when
  - Total connected power $\leq$ Interior lighting power budget

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Total Connected Interior Lighting Power *(Section 505.5.1)*

- Watts of all interior lighting equipment
- Except
  - Specialized medical, dental & research lighting
  - Professional sports arena playing field lighting
  - Display lighting of exhibits in galleries, museums & monuments
  - Sleeping unit lighting in hotels, motels, boarding houses or similar buildings
  - Emergency lighting automatically off during normal building operation

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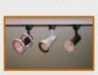
Calculating Installed Lighting Power

- Screw Lamp Holders *(Section 505.5.1.1)*
  - Use Maximum Labeled Wattage

- Low-Voltage Lighting *(Section 505.5.1.2)*
  - Specified Wattage of Transformer

- Other Luminaries *(Section 505.5.1.3)*
  - Manufactures Literature or Other Approved Resources



Line-Voltage Lighting Track & Plug-in Busway *(Section 505.5.1.4)*
  - Greater of 30 Watts/Linear Foot or Calculated Wattage

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Interior Lighting Power Budget

Use Table 505.5.2 Interior Lighting Power Allowances

Where both a general building area type and a more specific building area type are listed, the more specific type shall apply

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Interior Lighting Power

TABLE 505.5.2
INTERIOR LIGHTING POWER ALLOWANCES

Building Area Type[a]	LIGHTING POWER DENSITY (W/ft²)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Healthcare-Clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multi-Family	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail[b]	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

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Additional Lighting Allowances

(Table 505.5.2, footnote b)

- Display Lighting to highlight specific merchandise
  - The <u>lesser</u> of 1.6 w/ft² x specific display area, (not to exceed 50% of the floor area) **or**
  - The <u>lesser</u> of 3.9 w/ft² x case or shelf area **or**
  - Actual wattage of lighting equipment
  - Add to general lighting allotment
  - **Must be switched on separate circuit**

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Exterior Lighting *(Section 505.6)*

Criteria

- Lighting power supplied through building electrical service, not including low-voltage landscape lighting
  - Historical, safety, signage or emergency may be approved
- Luminaries greater than 100 watts must contain lamps that have a minimum efficacy of 60 lumens/watt
  - Exception
    - When controlled by a motion sensor
    - If qualifies under 505.6.2

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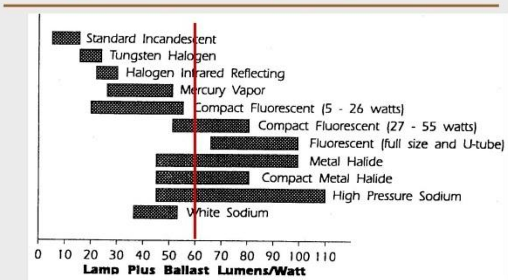
Energy Efficient Lighting Sources



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Exterior Lighting Power *(Section 505.6.2)*

- Calculated using allowances in Table 505.6.2
  - Exceptions
    - Transportation signal and directional lighting
    - Advertising signage
    - Integral to equipment and installed by manufacturer
    - Theatrical lighting
    - Athletic playing areas
    - Temporary lighting
    - Industrial production, material handling, transportation
    - Theme elements in amusement parks
    - Public monuments, registered historical structures or buildings

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TABLE 505.6.2
LIGHTING POWER DENSITIES FOR BUILDING EXTERIORS

APPLICATIONS	LIGHTING POWER DENSITIES
Tradable Surfaces (Lighting Power Densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs, and outdoor sales areas may be traded.)	
Uncovered Parking Areas	
Parking Lots and drives	0.15 W/ft²
Building Grounds	
Walkways less than 10 feet wide	1.0 watts/linear foot
Walkways 10 feet wide or greater, plaza areas and special feature areas	0.2 W/ft²
Stairways	1.0 W/ft²
Building Entrances and Exits	
Main entries	30 watts/linear foot of door width
Other doors	20 watts/linear foot of door width
Canopies and Overhangs	
Canopies (free standing & attached and overhangs)	1.25 W/ft²
Outdoor Sales	
Open areas (including vehicle sales lots)	0.5 W/ft²
Street frontage for vehicle sales lots in addition to "open area" allowance	20 watts/linear foot
Nontradable Surfaces (Lighting Power Density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the Tradable Surfaces section of this table.)	
Building facades	0.2 W/ft² for each illuminated wall or surface or 5.0 Watts/linear foot for each illuminated wall or surface length
Automated teller machines and night depositories	270 watts per location plus 90 watts per additional ATM per location
Entrances and gatehouse inspection stations at guarded facilities	1.25 W/ft² of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces)
Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft² of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces)
Drive-up windows at fast food restaurants	400 watts per drive-through
Parking near 24-hour retail entrances	800 watts per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m².

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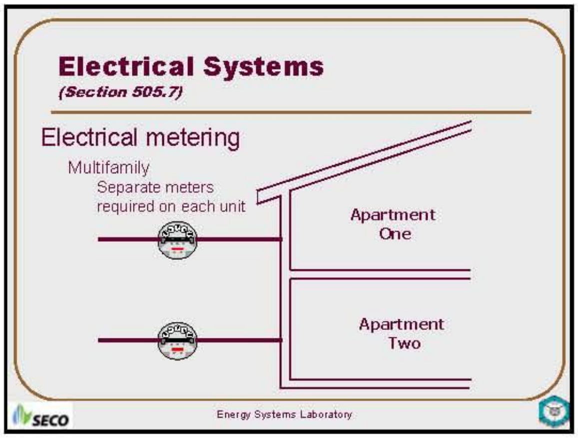
Electrical Systems
(Section 505.7)
Electrical metering
Multifamily
Separate meters
required on each unit
Apartment
One
Apartment
Two
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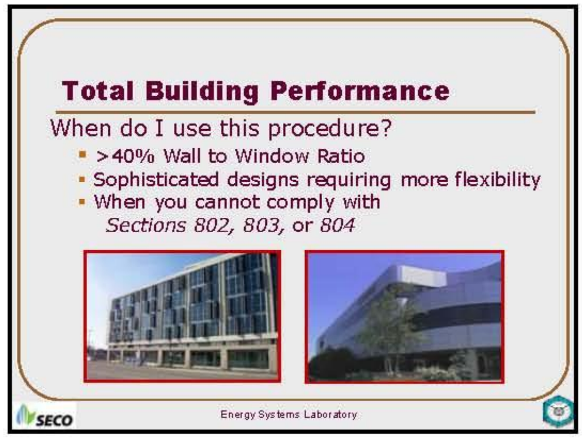
Total Building Performance
When do I use this procedure?
>40% Wall to Window Ratio
Sophisticated designs requiring more flexibility
When you cannot comply with
Sections 802, 803, or 804
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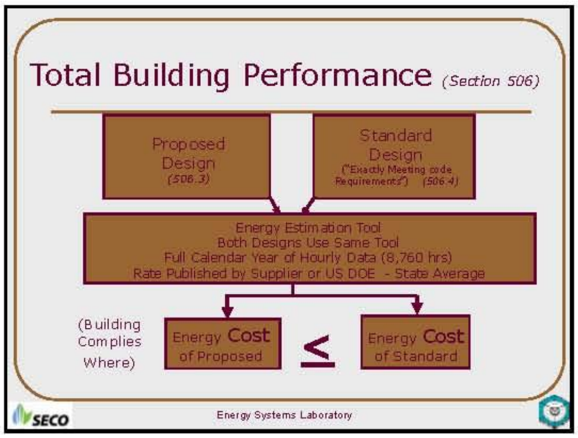
Total Building Performance (Section 506)
Proposed
Design
(506.3)
Standard
Design
("Exactly Meeting code
Requirements") (506.4)
Energy Estimation Tool
Both Designs Use Same Tool
Full Calendar Year of Hourly Data (8,760 hrs)
Rate Published by Supplier or US DOE - State Average
(Building
Complies
Where)
Energy Cost
of Proposed
≤
Energy Cost
of Standard
SECO
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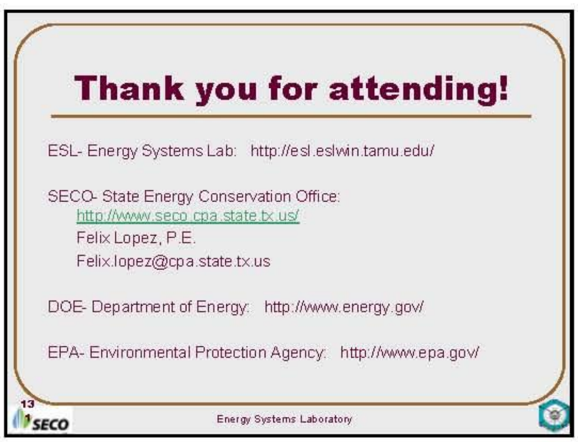
Questions and Answers
SECO
State Energy Conservation Office
IC3
International
CODE
COMPLIANCE
CALCULATOR
SECO
Energy Systems Laboratory


Thank you for attending!
ESL- Energy Systems Lab: http://esl.eslwin.tamu.edu/
SECO- State Energy Conservation Office:
http://www.seco.cpa.state.tx.us/
Felix Lopez, P.E.
Felix.lopez@cpa.state.tx.us
DOE- Department of Energy: http://www.energy.gov/
EPA- Environmental Protection Agency: http://www.epa.gov/
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Five (5) Commercial International Energy Conservation Code classes were offered in 2009.

TITLE	LOCATION	DATE	ATTENDEES
Com - 2006 IECC	Arlington	5/18/2009	39
Com - 2006 IECC	Allen	8/21/2009	7
Com - 2006 IECC	Amarillo	7/16/2009	16
Com - 2006 IECC	Houston CATEE	10/15/2009	3
Com - 2006 IECC	Mansfield	8/20/2009	17
		TOTAL	82

Presented by Ed Dryden
July 16, 2009

IECC 2006 Commercial - Amarillo

#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Barry Osborne	B & W Pantex	2608 S. Taylor	Amarillo	TX	79109	dbarryo@suddenlink.net	806-674-2766	✓
2	James Halmer	Bluehaven Homes	1900 SE 34th Suite 300	Amarillo	TX	79118	james@williamsgroup.com	806-373-5820	
3	Randy Schuster	City of Amarillo	509 S. 7th	Amarillo	TX	79101	randy.schuster@amarillo.gov	806-378-3042	✓
4	Kevin Robinson	City of Amarillo	210 W. Mobley # 11	Amarillo	TX	79108	kevin.robinson@amarillo.gov	806-673-7561	
5	Donny Cornelius	City of Canyon	301 16th St.	Canyon	TX	79015	dcornelius@canyontx.com	806-655-5014	✓
6	Dwain Sumpter	City of Childress	PO Box 1087	Childress	TX	79201		940-937-3683	
7	Karen Hutson	City of Dimmitt	PO Box 146	Dimmitt	TX	79027	khutdim@amaonline.com	806-647-4492	
8	Amy Taylor	CRL Architect	619 S. Tyler Ste 100	Amarillo	TX	79101	ataylor@crlarchitect.com	806-374-0676	✓
9	Mark Phillips	Lavin Architects	2810 Duniven Circle # 100	Amarillo	TX	79109	mphillips@lavinarchitects.com	806-358-7069	✓
10	Sarah DeGrood	Lavin Architects	2810 Duniven Circle # 100	Amarillo	TX	79109	sdegrood@lavinarchitects.com	806-358-7069	✓
11	Michael Green	Michael E. Green Architect	7813 Harrington	Amarillo	TX	79121	green82@nts-online.net	806-353-3970	✓
12	Russell Megert	Shiver-Megert & Assoc.	102 E. 9th Ave. Suite 200	Amarillo	TX	79101	russell@smaae.com	806-372-5662	✓
13	John Abbott	Shiver-Megert & Assoc.	102 E. 9th Ave. Suite 200	Amarillo	TX	79109	john@smaae.com	806-372-5662	✓
14	Darrell Fleming	Shiver-Megert & Assoc.	102 E. 9th Ave. Suite 200	Amarillo	TX	79101		806-372-5662	✓
15	W.M. Parr		7619 Cervin Dr.	Amarillo	TX	79121	bilandmax@suddenlink.net	806-353-1331	✓
16	Frank Nelson		3210 Austin St.	Amarillo	TX	79109	frank-mj@msn.com	806-335-0894	

Presented by Ed Dryden
August 17, 2009

IECC 2006 Commercial - Allen

#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Michael Almassi	City of Allen	305 Century Parkway	Allen	TX	75013	malmassi@cityofallen.org	214-509-4141	✓
2	G. Paul Drake	City of McKinney	221 N. Tennessee	McKinney	TX	75070	pdrake@mckinneytexas.org	214-906-0358	✓
3	Mike Crain	City of Frisco	6101 Frisco Sq. Blvd.	Frisco	TX	75034	mcrain@friscotexas.gov	972-670-4445	✓
4	Howard Harbin	City of Allen	305 Century Parkway	Allen	TX	75013	hharbin@cityofallen.org	214-509-4140	
5	James Shelton	City of Frisco	6101 Frisco Sq.	Frisco	TX	75034	jshelton@friscotexas.gov	972-670-4392	
6	Les Folse	City of Allen	305 Century Parkway	Allen	TX	75013	lfolse@cityofallen.org	214-509-4135	✓
7	Poley Birika	City of Frisco	6101 Frisco Sq. Blvd	Frisco	TX	75034	pbirika@friscotexas.gov	972-292-5346	✓

IECC 2006 Commercial - BPI Arlington 5/18/2009

#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Bobby Bennett								
3	Terry Brewer								
6	Shon Brooks								
9	Robert Brown								
2	Liz Ciolino								
4	Michael Climer								
5	Cherie Delude								
7	Charles Dosch								
8	Shawn Earl								
10	Ross Emmett								
11	Larry Ewing								
12	Joseph Ferraro								
13	Michael Hall								
14	Ramie Hammonds								
15	Jeanene Heilman								
16	Ray Hopkins								
17	Tommy Jones								
18	Sharlynn Keys								
19	Marilu Madrigal								
20	Harry Manley								
21	WI McCulloch								
22	Eddie Mitchell								
23	Cynthia Montgomery								
24	Janelle Montgomery								
25	Jeff Reed								
26	Rene Rodriguez								
27	Steve Saunders								
28	John Sharpe								
29	Ronald Skiles								
30	William Slavik								
31	Bob Stevenson								
32	Chris Tucker								
33	Kevin Tucker								
34	Richard Windham								
35	Thomas Wood								
36	Robert Younger								
37	Laurie Barham								
38	Charles Bloomberg								
39	Ronald Wesolak								

Presented by Shirley Muns
October 15, 2009

CATEE 2009 - IECC Com

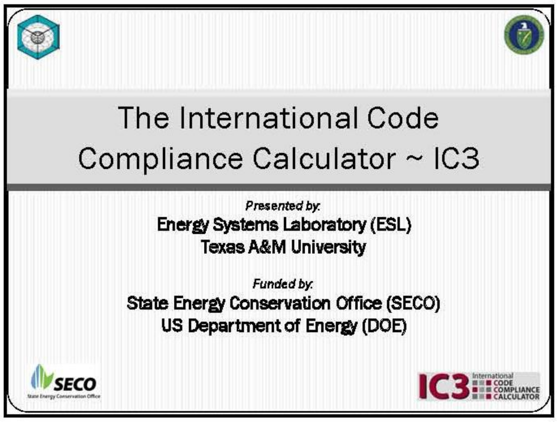
#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Brannon King						brannon.king@dpis.com		✓
2	Jeffrey Solak						jsolak@wje.com		✓
3	Gali Zilbershtein						galiez@tamu.edu		✓

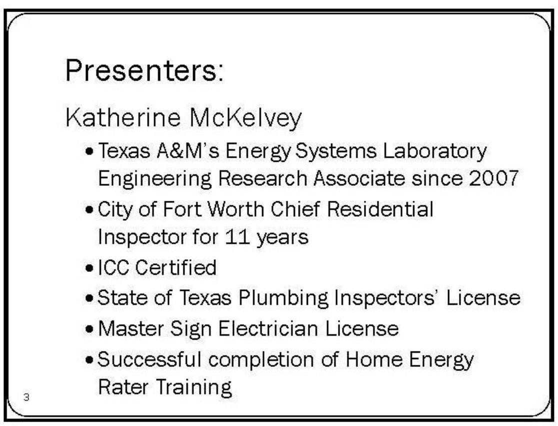
Presented by Ed Dryden
August 20, 2009

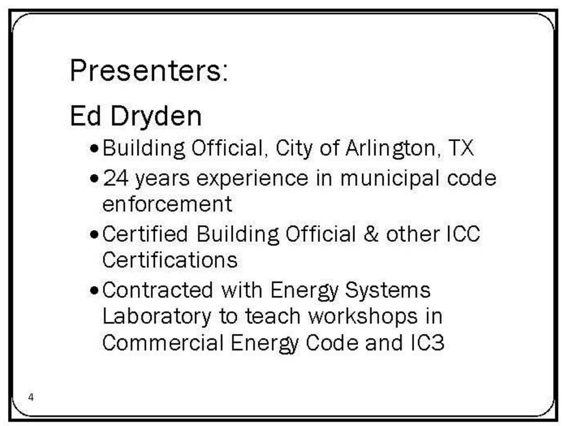
IECC 2006 Commercial - Mansfield

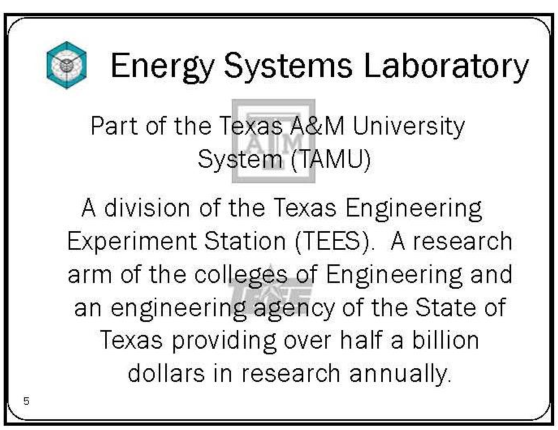
#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	James Williams	City of Benbrook	911 Winscott Rd.	Benbrook	TX	76126	jwilliams@cityofbenbrook.com	817-249-3000	✓
2	Joel Huff	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	joel.huff@cityofcarrollton.com	972-466-5752	✓
3	Billy McMahon	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	billy.mcmahon@cityofcarrollton.com	214-546-0155	✓
4	Willie Lee Stevenson	City of Cleburne	10 N. Robinson	Cleburne	TX	76033	willie.stevenson@cleburne.net	817-556-8801	✓
5	Robert Chatham	City of Irving	825 W. Irving Blvd	Irving	TX	75060	rchatham@cityofirving.org	972-721-4888	✓
6	Lawrence Crow	City of Irving	825 W. Irving Blvd	Irving	TX	75060	lcrow@cityofirving.org	972-721-4875	
7	Sana Touma	City of Mansfield	1200 E. Broad St.	Mansfield	TX	76063	sana.touma@ci.mansfield.tx.us	817-276-4277	✓
8	Terri Carter	City of Mansfield	1200 E. Broad St.	Mansfield	TX	76063	terri.carter@mansfield-tx.gov	817-276-4230	✓
9	Paul Coker	City of Mansfield	1200 E. Broad St.	Mansfield	TX	76063	paul.coker@mansfield-tx.gov	817-276-4223	✓
10	Morris Cowden	City of Mansfield	1200 E. Broad St.	Mansfield	TX	76063	morris.cowden@ci.mansfield.tx.us	817-276-4200	✓
11	Wendell Thomas	City of Mansfield	1200 E. Broad St.	Mansfield	TX	76063	wendell.thomas@ci.mansfield.tx.us	817-276-4200	✓
12	John Shannon	City of Rockwall	385 S. Goliad St.	Rockwall	TX	75087	jshannon@rockwall.com	972-772-6481	✓
13	John Ankrum	City of Rockwall	385 S. Goliad St.	Rockwall	TX	75087	jankrum@rockwall.com	972-772-6774	
14	James Bruce Ellis	Town of Addison	PO Box 9010	Addison	TX	75001	bellisw@addisontx.org	972-450-2888	✓
15	Dale McKendrick	Town of Little Elm	100 W. El Dorado Blvd.	Little Elm	TX	75068	dmckendrick@littleelm.org	214-975-0457	✓
16	Jack Foster	Town of Little Elm	100 W. El Dorado Blvd.	Little Elm	TX	75068	jfoster@littleelm.org	214-975-0458	✓
17	Chad Joyce	Town of Pantego	1614 S. Bowen Rd.	Pantego	TX	76013	cjoyce@townofpantego.com	817-860-1681	✓

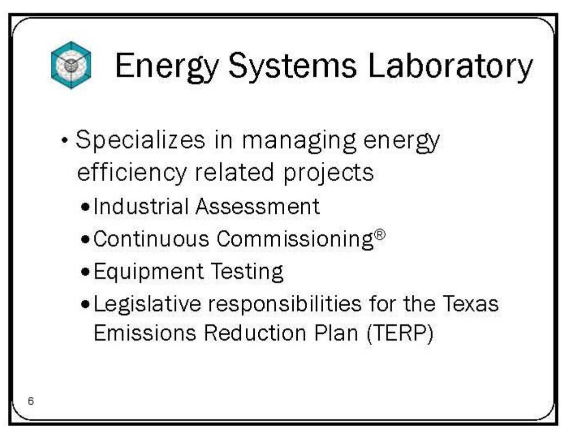
Many enhancements were added in the development of the International Code Compliance Calculator (IC3). 2009 saw the addition of three-story, pier and beam, and multifamily. Workshops were developed to train Users in the IC3 software application.











Energy Systems Laboratory

Continuous Commissioning®

7

Energy Systems Laboratory

Equipment Testing Services

8

Texas Emission Reduction Plan (TERP)

- Established by 77th Texas Legislature in 2001, through enactment of Senate Bill 5
  - Assures that the air in Texas is safe to breathe
  - Develops approaches to solving environmental problems
  - Funds research and development
  - Establishes Texas Building Energy Performance Standards

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Texas Emission Reduction Plan (TERP)

- Texas Building Energy Performance Standards
  - Assigned the Energy Systems Laboratory (ESL) to:
    - Help municipalities and counties determine the relative impacts of local amendments to the code
    - Report the status and effect of energy & emissions as impacted by local codes

10

Texas Emission Reduction Plan (TERP)

- Texas Building Energy Performance Standards
  - Assigned the Energy Systems Laboratory (ESL) to:
    - Help municipalities and counties determine the relative impacts of local amendments to the code
    - Report the status and effect of energy & emissions as impacted by local codes

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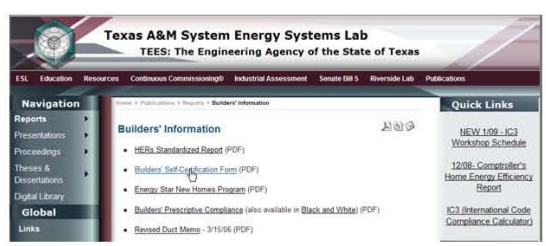
Energy Systems Laboratory

http://esl.eslwin.tamu.edu/reports/builders-information.html



Texas Emission Reduction Plan (TERP)

- Texas Building Energy Performance Standards
  - Sets the 2000 International Residential Code and the 2000 International Energy Conservation Code (IECC) with the 2001 Supplement, as the first state mandated energy codes for the State of Texas

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Texas Emission Reduction Plan (TERP)

- Texas Building Energy Performance Standards

  •2000 International Residential Code as applicable for 1- and 2- family residential construction

  •2000 International Energy Conservation Code with the 2001 Supplement for use in all other residential, commercial, and industrial construction.

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Texas Emission Reduction Plan (TERP)

<u>Texas Building Energy Performance Standards</u>

- Designed to save energy by:
  - Reducing solar heat gain
  - Improving the performance of HVAC ducts
  - Requiring openings in the thermal envelope to be sealed against air leaks
  - Setting minimum insulation levels for thermal envelope assemblies

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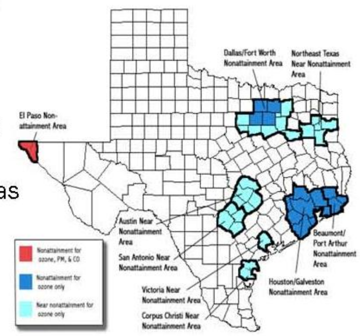
Texas Emission Reduction Plan (TERP)

Texas' Non-attainment and Near Non-attainment Areas



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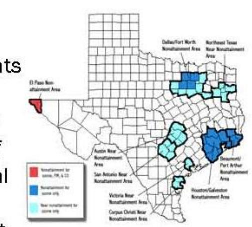
Texas Emission Reduction Plan (TERP)

Municipalities or counties may adopt local amendments to the International Energy Conservation Code and the energy efficiency chapter of the International Residential Code, however these amendments may not result in less stringent energy efficiency requirements in nonattainment areas and affected counties.



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Energy Systems Laboratory

- Developed a series of web-based calculators allowing Texas Government and Building Industry users to design energy efficient buildings at or above code, thus documenting their emissions reductions
- International Code Compliance Calculator (IC3) was developed for residential new construction
- Many jurisdictions mandate the use of IC3

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Software Development

- International Code Compliance Calculator (IC3)
  - Based on the Texas Building Energy Performance Standards
  - A performance-based residential energy code compliance tool
  - Designed specifically to be used in residential construction within the state of Texas

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International Code Compliance Calculator – IC3

- Developed with emphasis on simplicity
- ESL's goal is to develop an easy-to-use, easy-to-access simulated performance based tool that could be used to show code compliance and to report reduced energy consumption to the US EPA

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Let's Get Started!...

The first thing you need to do is type

http://ic3.tamu.edu

in your browser

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IC3 First Page

User Login

Welcome! This is publicly accessible energy code compliance software based on the Texas Building Energy Performance Standards. You must register a username and password in order to continue. You may then access your records using your user name and password.

Email Address:

Password:

Login

Register Forgot Password

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IC3 Registration Page

Registration

Email Address:

Password:

Repeat Password:

Register

23

IC3 Login Page

User Login

Welcome! This is publicly accessible energy code compliance software based on the Texas Building Energy Performance Standards. You must register a username and password in order to continue. You may then access your records using your user name and password.

Email Address:

Password:

Login

Register Forgot Password

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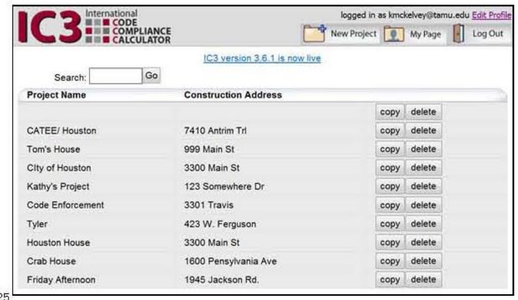
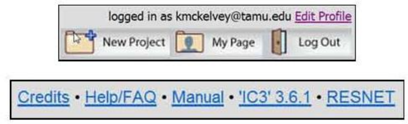
IC3 My Page



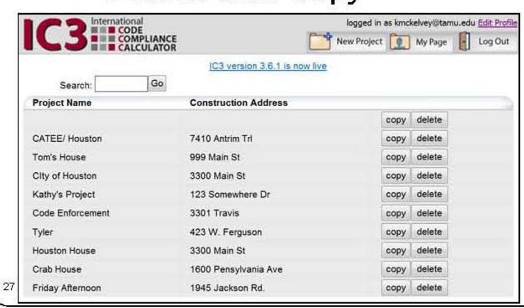
25

IC3 My Page ~ Links



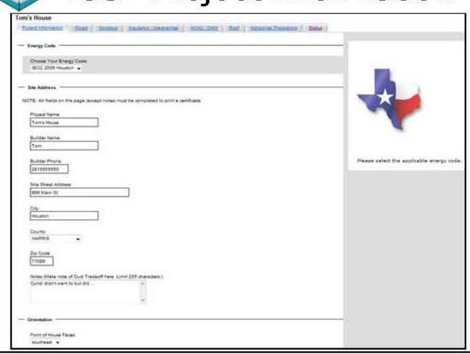
26

IC3 My Page ~ Projects Delete and Copy



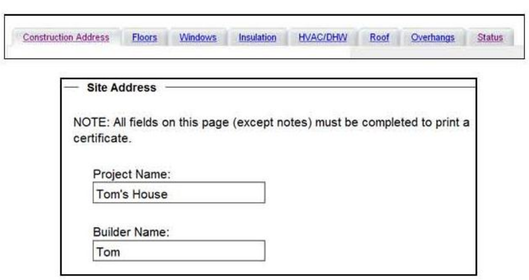
27

IC3 - Project Information



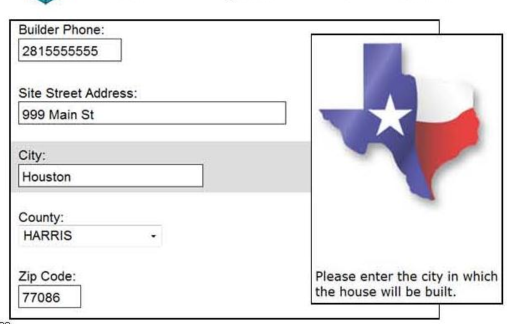
28

IC3 - Project Information

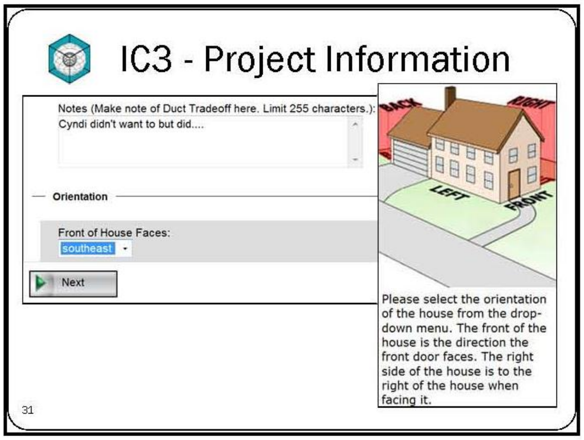


29

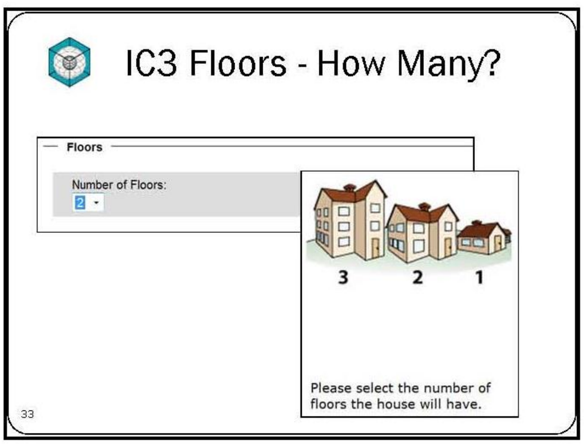
IC3 - Project Information

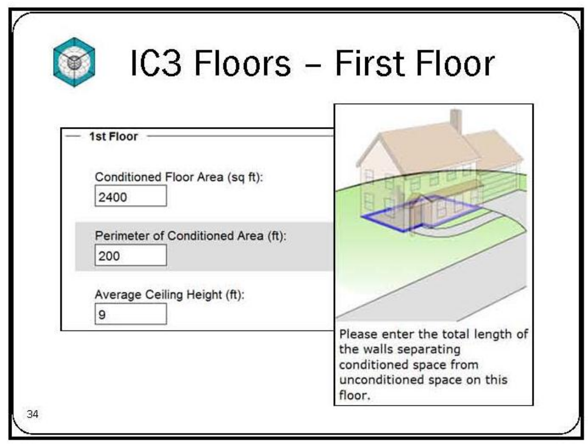


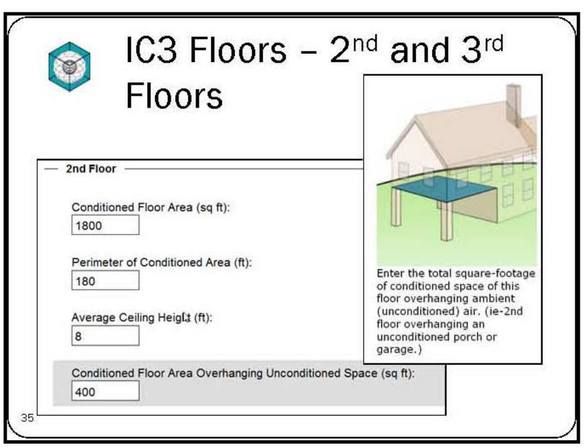
30

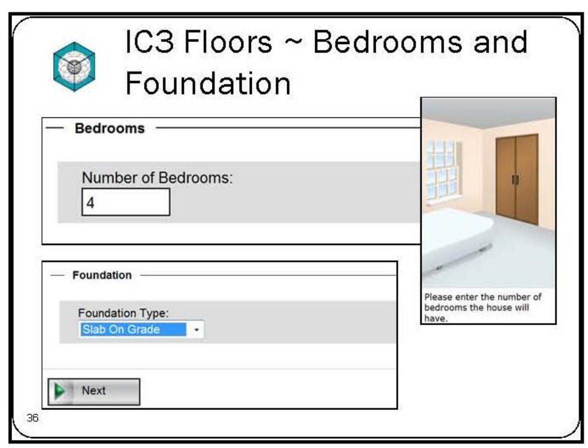

IC3 - Project Information
Notes (Make note of Duct Tradeoff here. Limit 255 characters.):
Cyndi didn't want to but did....
Orientation
Front of House Faces:
southeast
Next
BACK
RIGHT
LEFT
FRONT
Please select the orientation of the house from the drop-down menu. The front of the house is the direction the front door faces. The right side of the house is to the right of the house when facing it.
31

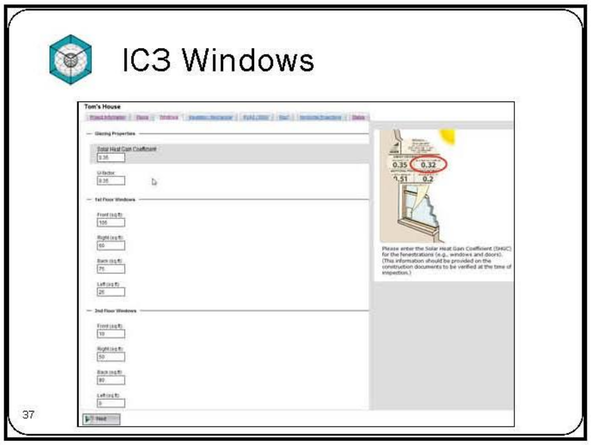

IC3 Floors
32

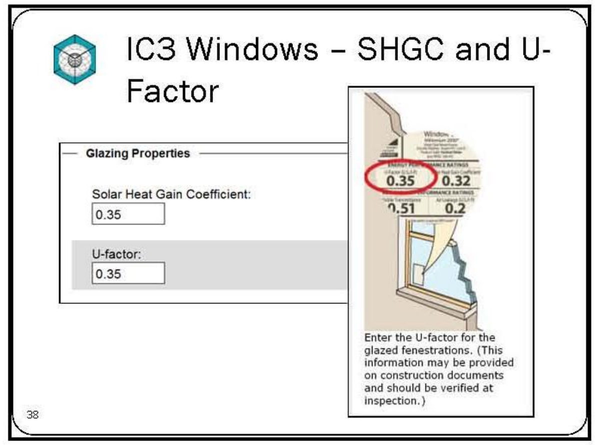

IC3 Floors - How Many?
Floors
Number of Floors:
2
3
2
1
Please select the number of floors the house will have.
33

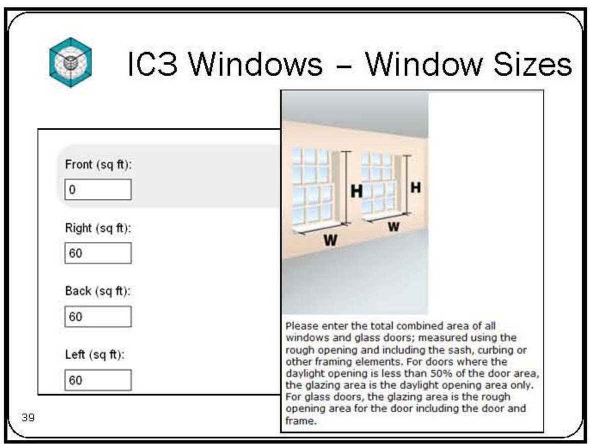

IC3 Floors – First Floor
1st Floor
Conditioned Floor Area (sq ft):
2400
Perimeter of Conditioned Area (ft):
200
Average Ceiling Height (ft):
9
Please enter the total length of the walls separating conditioned space from unconditioned space on this floor.
34

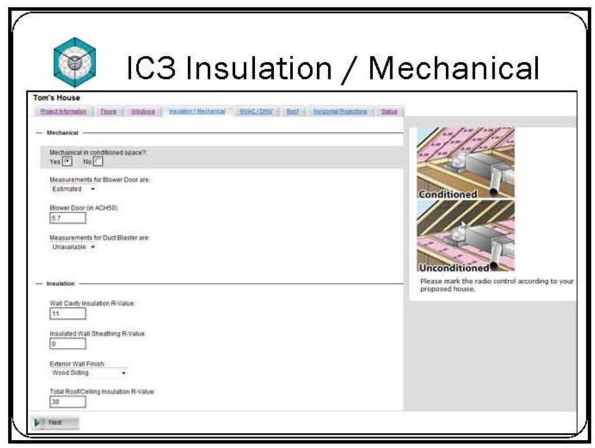

IC3 Floors – 2nd and 3rd Floors
2nd Floor
Conditioned Floor Area (sq ft):
1800
Perimeter of Conditioned Area (ft):
180
Average Ceiling Height (ft):
8
Conditioned Floor Area Overhanging Unconditioned Space (sq ft):
400
Enter the total square-footage of conditioned space of this floor overhanging ambient (unconditioned) air. (ie-2nd floor overhanging an unconditioned porch or garage.)
35

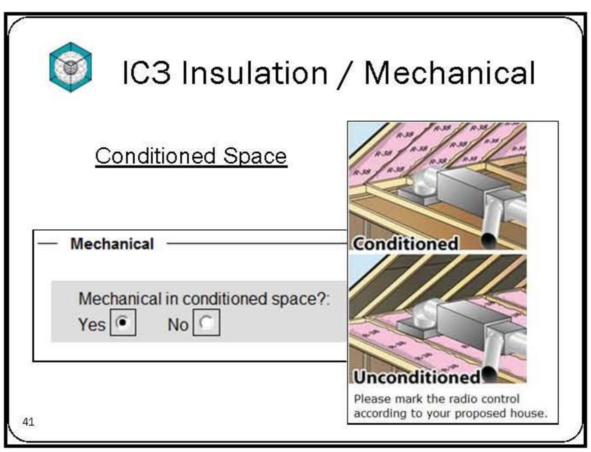

IC3 Floors ~ Bedrooms and Foundation
Bedrooms
Number of Bedrooms:
4
Foundation
Foundation Type:
Slab On Grade
Next
Please enter the number of bedrooms the house will have.
36

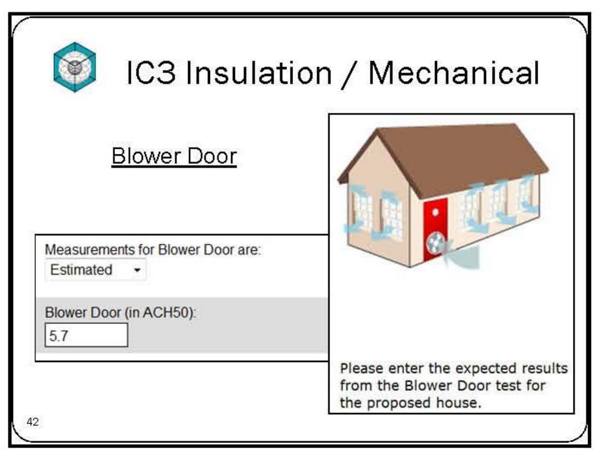

IC3 Windows
37

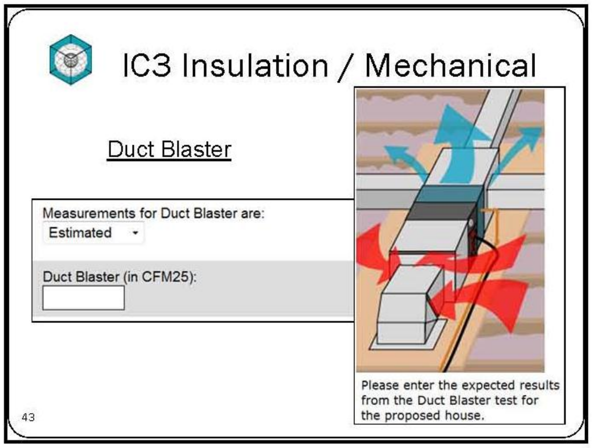

IC3 Windows – SHGC and U-Factor
Glazing Properties
Solar Heat Gain Coefficient:
0.35
U-factor:
0.35
0.35
0.32
0.51
0.2
Enter the U-factor for the glazed fenestrations. (This information may be provided on construction documents and should be verified at inspection.)
38

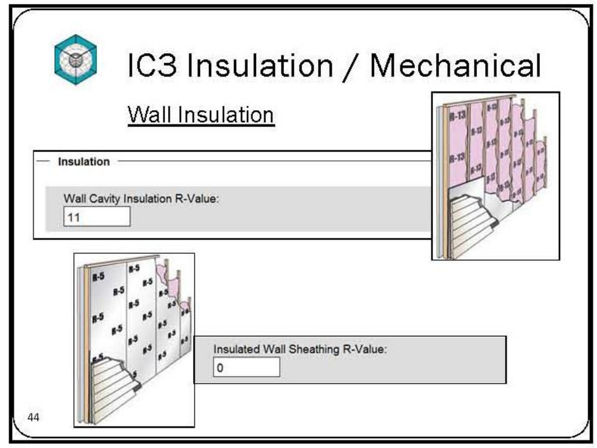

IC3 Windows – Window Sizes
Front (sq ft):
0
Right (sq ft):
60
Back (sq ft):
60
Left (sq ft):
60
H
H
W
W
Please enter the total combined area of all windows and glass doors; measured using the rough opening and including the sash, curbing or other framing elements. For doors where the daylight opening is less than 50% of the door area, the glazing area is the daylight opening area only. For glass doors, the glazing area is the rough opening area for the door including the door and frame.
39

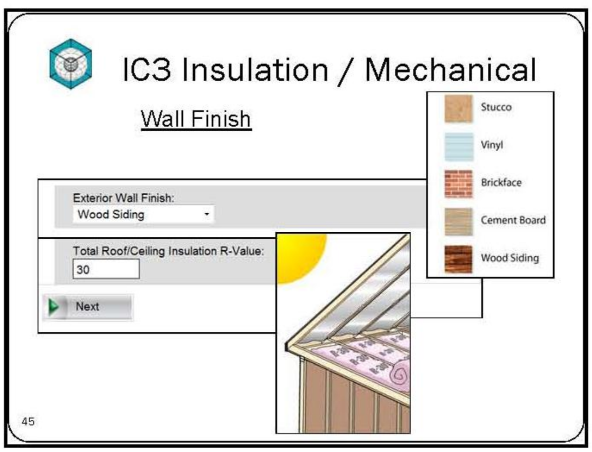

IC3 Insulation / Mechanical
Tom's House
Conditioned
Unconditioned
Please mark the radio control according to your proposed house.


IC3 Insulation / Mechanical
Conditioned Space
Mechanical
Mechanical in conditioned space?:
Yes
No
Conditioned
Unconditioned
Please mark the radio control according to your proposed house.
41

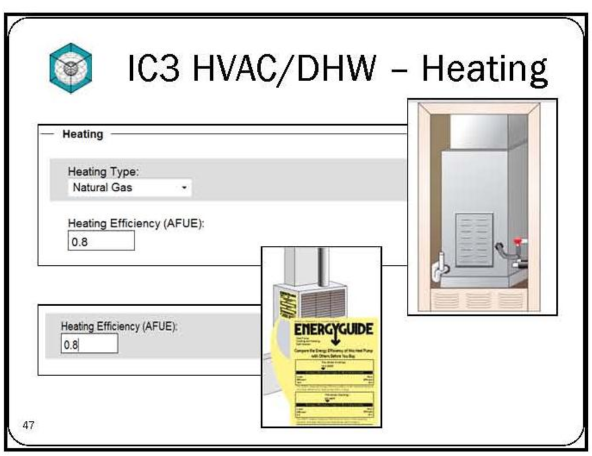

IC3 Insulation / Mechanical
Blower Door
Measurements for Blower Door are:
Estimated
Blower Door (in ACH50):
5.7
Please enter the expected results from the Blower Door test for the proposed house.
42

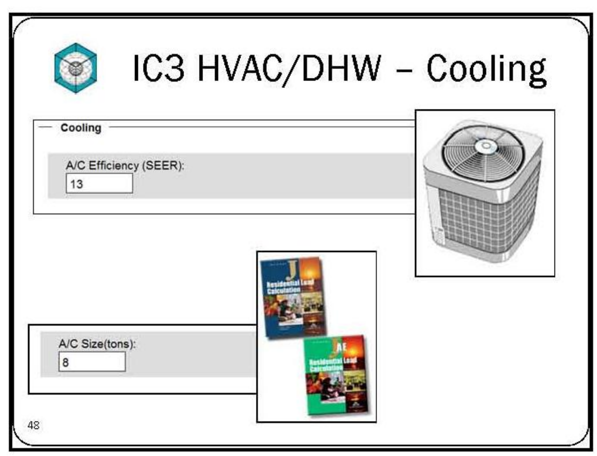

IC3 Insulation / Mechanical
Duct Blaster
Measurements for Duct Blaster are:
Estimated
Duct Blaster (in CFM25):
Please enter the expected results from the Duct Blaster test for the proposed house.
43

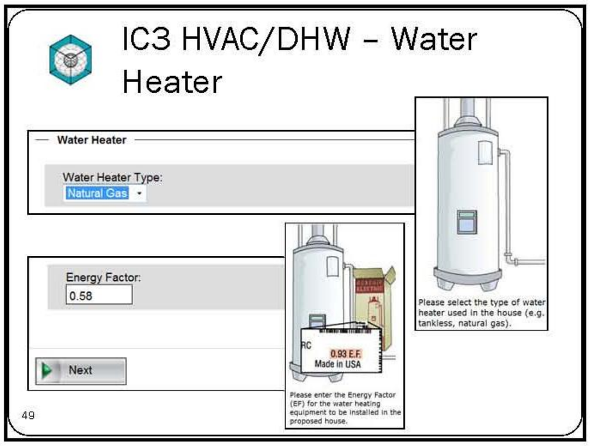

IC3 Insulation / Mechanical
Wall Insulation
Insulation
Wall Cavity Insulation R-Value:
11
Insulated Wall Sheathing R-Value:
0
44


IC3 Insulation / Mechanical
Wall Finish
Stucco
Vinyl
Brickface
Cement Board
Wood Siding
Exterior Wall Finish:
Wood Siding
Total Roof/Ceiling Insulation R-Value:
30
Next
45

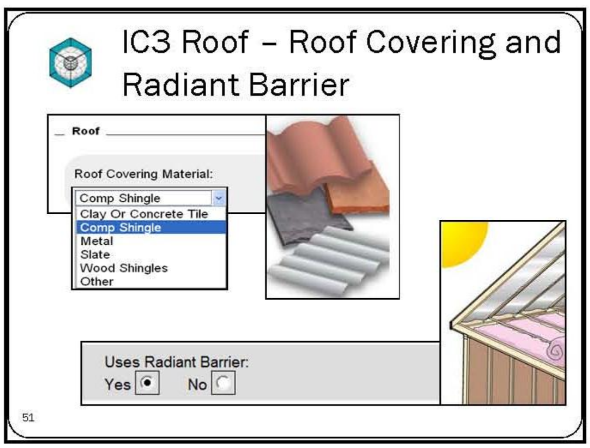

IC3 HVAC/DHW
Tom's House
Heating
Heating Type:
Natural Gas
Heating Efficiency (AFUE):
0.8
Cooling
A/C Efficiency (SEER):
13
A/C Size(tons):
8
Water Heater
Water Heater Type:
Natural Gas
Energy Factor:
0.58
Please select the heating type for the house (e.g., heat pump, natural gas).
Next
46

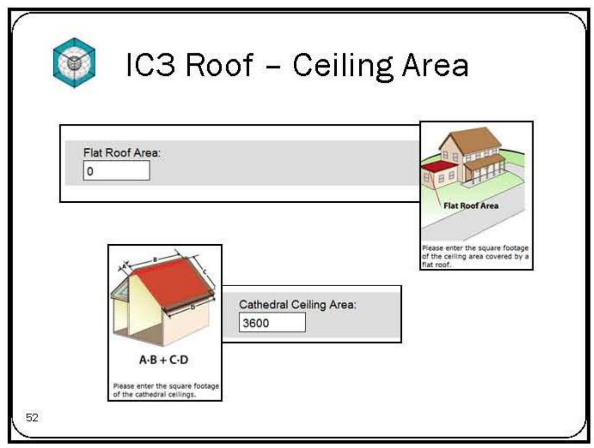

IC3 HVAC/DHW – Heating
Heating
Heating Type:
Natural Gas
Heating Efficiency (AFUE):
0.8
Heating Efficiency (AFUE):
0.8
ENERGYGUIDE
47

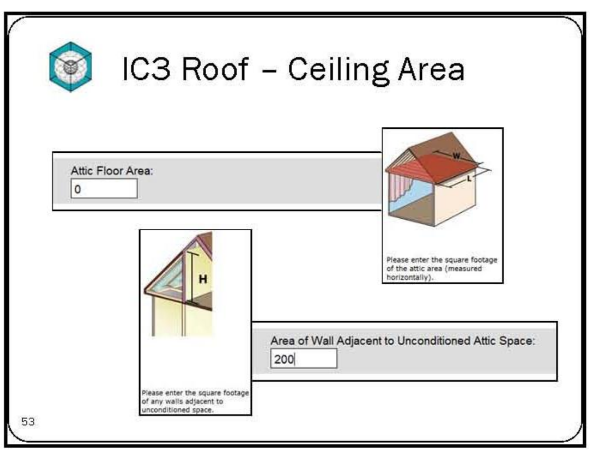

IC3 HVAC/DHW – Cooling
Cooling
A/C Efficiency (SEER):
13
A/C Size(tons):
8
48

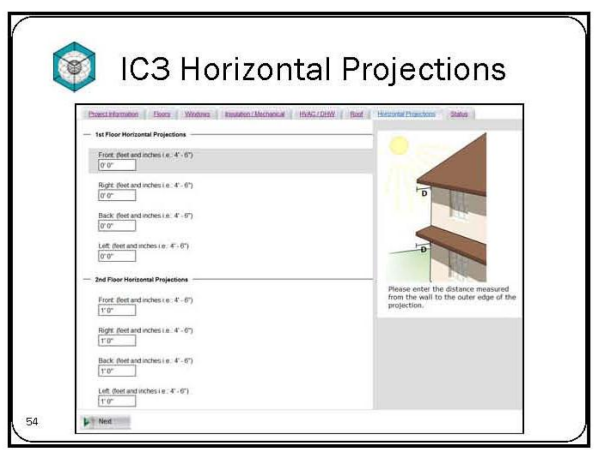

IC3 HVAC/DHW – Water Heater
Water Heater
Water Heater Type:
Natural Gas
Energy Factor:
0.58
Next
0.93 E.F.
Made in USA
Please enter the Energy Factor (EF) for the water heating equipment to be installed in the proposed house.
Please select the type of water heater used in the house (e.g. tankless, natural gas).
49

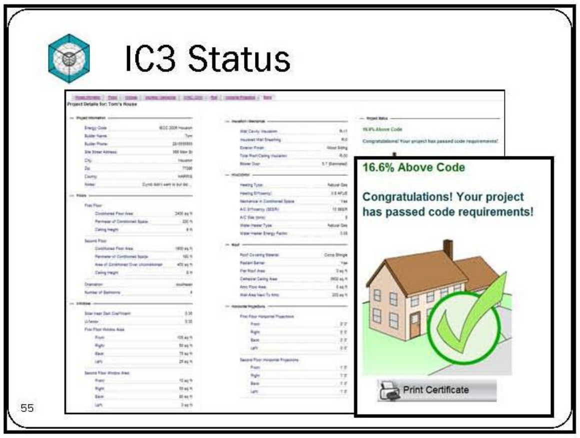

IC3 Roof
Tom's House
Please select the type of roof covering for the proposed house.
50

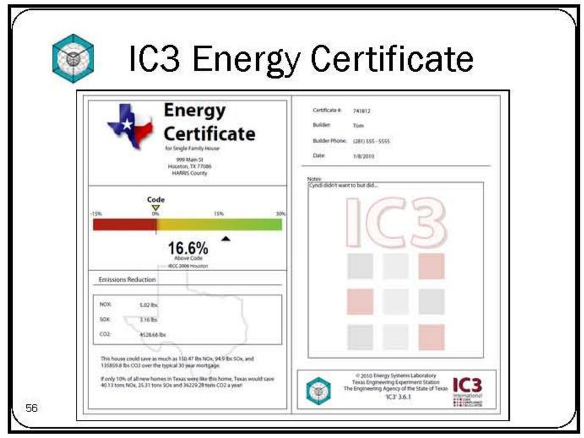

IC3 Roof – Roof Covering and Radiant Barrier
Roof
Roof Covering Material:
Comp Shingle
Clay Or Concrete Tile
Comp Shingle
Metal
Slate
Wood Shingles
Other
Uses Radiant Barrier:
Yes
No
51

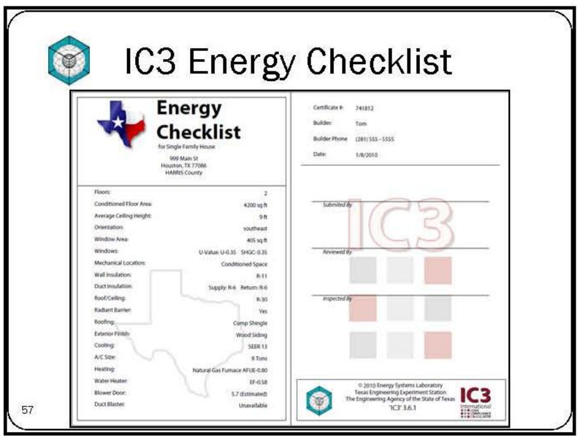

IC3 Roof – Ceiling Area
Flat Roof Area:
0
Flat Roof Area
Please enter the square footage of the ceiling area covered by a flat roof.
A·B + C·D
Please enter the square footage of the cathedral ceilings.
Cathedral Ceiling Area:
3600
52


IC3 Roof – Ceiling Area
Attic Floor Area:
0
Please enter the square footage of the attic area (measured horizontally).
H
Please enter the square footage of any walls adjacent to unconditioned space.
Area of Wall Adjacent to Unconditioned Attic Space:
200
53


IC3 Horizontal Projections
1st Floor Horizontal Projections
2nd Floor Horizontal Projections
Please enter the distance measured from the wall to the outer edge of the projection.
54


IC3 Status
16.6% Above Code
Congratulations! Your project has passed code requirements!
Print Certificate
55


IC3 Energy Certificate
Energy Certificate
Code
16.6%
Emissions Reduction
IC3
56


IC3 Energy Checklist
Energy Checklist
IC3
57


IC3 International CODE COMPLIANCE CALCULATOR
TEES
Questions and Answers
ESL's Contact information
IC3 Support
Ic3_support@esl.tamu.edu
Katherine McKelvey
(979) 845-1781
Kmckelvey@tamu.ed u
HERO
SECO
State Energy Conservation Office
58


Thank you for attending!
ESL- Energy Systems Lab:
http://esl.eslwin.tamu.edu/
Ed Dryden
Ed.Dryden@arlingtontx.gov
SECO- State Energy Conservation Office:
http://www.seco.cpa.state.tx.us/
Felix Lopez
Felix.lopez@cpa.state.tx.us
DOE- Department of Energy:
http://www.energy.gov/
EPA- Environmental Protection Agency:
http://www.epa.gov/
59

Sixteen IC3 software training classes were held in 2009.

TITLE	LOCATION	DATE	ATTENDEES
IC3	Fort Worth	1/16/2009	15
IC3	Missouri City	1/23/2009	5
IC3	Mesquite	2/20/2009	3
IC3	Wichita Falls	2/27/2009	9
IC3	Arlington	5/18/2009	21
IC3	Abilene	6/3/2009	18
IC3	Brownsvile	7/8/2009	9
IC3	Longview	7/13/2009	8
IC3	Amarillo	7/17/2009	19
IC3	Carrollton	8/6/2009	9
IC3	De Soto	8/7/2009	4
IC3	McAllen	8/11/2009	15
IC3	Mansfield	8/20/2009	16
IC3	Tyler	9/14/2009	4
IC3	Houston	9/16/2009	70
IC3	Houston	9/17/2009	14
		TOTAL	**239**

IC3 BPI Arlington 5/18/2009

IC3 Presented by Ed Dryden

BPI Arlington, May 18, 2009

#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Bobby Bennett								
2	Noram Briceno								
3	Michael Climer								
4	Cherie Delude								
5	Mark Feighner								
6	Joseph Ferraro								
7	Mark Hickman								
8	Rhonda Johnson								
9	Tommy Jones								
10	Ward Lee								
11	Guy Lux								
12	Eddie Mitchell								
13	Cynthia Montgomery								
14	Henry Obidzienski								
15	Jeff O'Dell								
16	Julio Ruiz								
17	William Slavik								
18	Clint Sparks								
19	Chris Tucker								
20	Thomas Wood								
21	Sana Touma								

Presented by Kathy McKelvey

IC3 Brownsville 7-8-09

#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Jose Perez	Hispania Development Co. Inc.		Brownsville	TX	78521	jperez@hispaniadev.com	956-350-3366	
2	Protasio Guerra	Home & Commercial Designs LLC.	2390 Central Blvd. S-P	Brownsville	TX	78523	pguerrahcd@gmai.com	956-541-6865	
3	Richard Alvarez	City of Brownsville	1034 E. Levee 2nd Floor	Brownsville	TX	78520	ralvarez@cob.us	956-548-6125	
4	Julio Ruiz	City of Brownsville	1034 E. Levee	Brownsville	TX	78521	jruiz@cob.us	956-548-6165	
5	Carlos Yair Hernandez	Yair Construction	30 Providencia CT. Suite # 1	Brownsville	TX	78526	yair0321@gmail.com	956-346-0930	
6	Gerardo Lopez	Residential Plans and Design	30 Providencia CT.	Brownsville	TX	78521	residentialplans@gmail.com	956-433-1876	
7	Cynthia L. Cruz	City of Brownsville - Permitting Dept.	1034 E. Levee - 2nd Floor	Brownsville	TX	78520	clcruz@cob.us	956-548-6127	
8	Oscar Atkinson	Oscar Atkinson Designer	45 Honeydale Rd. `	Brownsville	TX	78520	ogatkinson@yahoo.com	956-548-1561	✓
9	Jose Luis Dlenis	A3D Designs / Infinity Designs	1393 E. Dition	Brownsville	TX	78526	A3D-Designs@yahoo.com	956-561-0360	

Presented by Ed Dryden

August 7, 2009

IC3 - DeSoto

	Name of Attendant	Company/Organization	Mailing Address	City	State	ZIP	E-Mail	Phone #
1	William R. Buros	B.C.C.S.	1302 Askbrook Dr.	Grand Prairie	TX	75052	will.buros@bccscode.com	214-791-2002
2	Shane Kress	B.C.C.S.	1303 Askbrook Dr.	Grand Prairie	TX	75053	shane.kress@bccscode.com	469-235-1906
3	Jack Lacy	City of De Soto	211 E. Pleasnt Run Rd.	DeSoto	TX	75115	jlacy@ci.desoto.tx.su	972-989-0409
4	Jack Thompson	City of De Soto	211 E. Pleasnt Run Rd.	DeSoto	TX	75115	jthompson@ci.desoto.tx.us	972-230-9621

Presented by Ed Dryden

IC3 Amarillo 7-17-09

#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Ryan Kuxhausen	Western Builders	700 S. Grant St.	Amarillo	TX	79105	rkuxhausen@wbamarillo.com	806-670-3827	
2	Joe A. Norman	Joe Norman Company	PO Box 19807	Amarillo	TX	79114	jnorman@suddenlinkmail.com	806-352-6555	
3	Donald E. Bartlett	City of Amarillo Bldg Safety	PO Box 1971	Amarillo	TX	79105	don.bartlett@amarillo.gov	806-378-6261	
4	W.M. Parr		7619 Cervin Dr.	Amarillo	TX	79121	bilandmax@suddenlink.net	806-353-1331	✓
5	Donny Cagle	Clarendon College	1902 Ave. G NW	Childress	TX	79201	donny.cagle@clarendoncollege.edu	940-937-2001	
6	James Halmer	Blue Haven Homes	1900 SE 34th Suite 300	Amarillo	TX	79118	james@williamsgroup.com	806-373-5820	
7	Tommy Stafford	Greenways	6003 Tuscany Vlg.	Amarillo	TX	79119	tommys@greenwaysofamarillo.com	806-467-1000	
8	Michael McCall	Western Builders	700 S. Grant St.	Amarillo	TX	79101	mmccall@wbamarillo.com	806-376-4321	
9	Frank Robinson	Western Builders	700 S. Grant St.	Amarillo	TX	79105	frobinson@wbamarillo.com	806-376-4321	
10	Kim Johnston	Dare to Dream Home Designs	1104 5th Ave.	Canyon	TX	79105	daretodream@suddenlinkmail.com	806-683-0303	
11	Michael Green	Michael E. Green Architect	7813 Harrington	Amarillo	TX	79121	green82@nts-online.net	806-353-3970	✓
12	Mike Trammell	N & B Homes	17301 Whitewing	Canyon	TX	79015	mike@nandbhomes.com	806-683-7974	
13	Gerald Chen	WTAMU	WT Box 61267	Canyon	TX	79016	gchen@mail.wtamu.edu	806-651-2449	
14	Larry Mullenix	City of Borger	PO Box 5250	Borger	TX	79008	lmullenix@ci.borger.tx.us	806-273-0910	
15	Larry Byrd	City of Borger	PO Box 5250	Borger	TX	79008	lbyrd@ci.borger.tx.us	806-231-9545	
16	Donny Cornelius	City of Canyon	301 16th St.	Canyon	TX	79015	dcornelius@canyontx.com	806-655-5014	✓
17	Dan Aldrich	City of Amarillo Bldg Safety	PO Box 1971	Amarillo	TX	79105	dan.aldrich@amarillo.gov	806-378-6095	✓
18	Robert Oliyares	Gregg Bliss Architect	619 S. Tyler Ste 100	Amarillo	TX	79101	robert@gbarchitect.net	806-372-2966	✓
19	Jonathan Morris	Charles R. Lynch AIA, Inc.	619 S. Tyler Ste 100	Amarillo	TX	79101	jmorris@crlarchitect.com	806-374-0678	

Presented by Kathy McKelvey
July 13, 2009

IC3 - Longview

	Name of Attendant	Company/Organization	Mailing Address	City	State	ZIP	E-Mail Address	Phone #
1	Pike Blakeley	Blakeley Enterprises	115 Community Blvd	Longview	TX	75605	pikeblakeley@msn.com	903-234-0110
2	James A. Williams	J.A.W. Marketing	5705 S.H. 300	Longview	TX	75604		903-297-2901
3	John Burciaga	Independent	212 Norris Dr.	Hallsville	TX	75650	jburc10715@aol.com	903-740-5608
4	John Clark	Classic Homes	3811 Clarkway	Longview	TX	75605	classichm@aol.com	903-663-6543
5	Terri Russell	City of Longview	PO Box 1952	Longview	TX	75605	trussell@ci.longview.tx.us	903-753-1075
6	Barry Lansford	Lansford Bldr. / First General Services	PO Box 9712	Longview	TX	75608	blans49295@aol.com	903-759-8803
7	Anwar Ichalifa	Pyramid Homes	5704 Churchill Dr.	Tyler	TX	75703	ichalifa@pyramidhomes.com	903-238-1033
8	Donnie Mitchell	Donnie Mitchel Inspections	13020 Shawntae Ln.	Tyler	TX	75703	dminspect@att.net	903-534-6564

Presented by Kathy McKelvey
August 6, 2009

IC3 - Carrollton

	Name of Attendant	Company/Organization	Mailing Address	City	State	ZIP	E-Mail Address	Phone #
1	Billy McMahon	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	billy.mcmahon@cityofcarrollton.com	214-546-0155
2	Brett King	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	brett.king@cityofcarrollton.com	172-466-3157
3	Mariann Tedder	City of McKinney	221 N. Tennessee	McKinney	TX	75070	mtedder@mckinnetexas.org	972-547-7476
4	Kathy Marcussen	City of McKinney	221 N. Tennessee	McKinney	TX	75070	kmarcussen@mckinneytexas.org	972-547-7446
5	Jeff Harris	City of McKinney	221 N. Tennessee	McKinney	TX	75070	jharris@mckinneytexas.org	972-547-7452
6	Sherry Copeland	City of Irving	825 W. Irving Blvd	Irving	TX	75060	scopeland@cityofirving.org	972-721-4886
7	Daniel Garcia	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	daniel.garcia@cityofcarrollton.com	972-466-3230
8	Joelle Hainley	Town of Flower Mound	2121 Cross Timbers Rd	Flower Mound	TX	75028	joelle.hainley@flower-mound.com	972-874-6367
9	Ray Hopkins	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	ray.hopkins@cityofcarrollton.com	972-466-3244

Presented by Kathy McKelvey

IC3 McAllen 8-11-09

#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Reynaldo Lucio	Cantu Construction	5221 N. McColl Rd.	McAllen	TX	78504	rey@cantuconstruction.com		
2	H. Jose Date	Cimco Engr Inc.	412 S. Bentsen Palm dr.	Palmview	TX	78572	h.date@sbcglobal.net	956-330-7986	✓
3	Heron Congoria Jr.	City of McAllen	1300 Houston Ave.	McAllen	TX	78501	hcongoria@mcallen.net	956-681-1300	✓
4	Saul Tores	City of McAllen	1300 Houston Ave.	McAllen	TX	78501	saultorres@mcallen.net	956-681-1300	✓
5	Roberto Gomez	City of McAllen	PO Box 324	Mercedes	TX	78570	robertosgomez@hotmail.com	956-793-2855	✓
6	Luis Vasquez	City of McAllen	3501 Raguel	McAllen	TX	78503	lvasquez@mcallen.net	956-681-1300	✓
7	Edalina Karr	City of McAllen	1300 Houston Ave.	McAllen	TX	78501	ekarr@mcallen.net	956-681-1300	✓
8	Juan Martinez	City of McAllen	1300 Houston Ave.	McAllen	TX	78501	juan_martinez@mcallen.net	956-681-1300	✓
9	Norma Yado	City of McAllen	1300 Houston Ave.	McAllen	TX	78501	nayado@mcallen.net	956-681-1300	✓
10	John Gutierrez	City of McAllen	2201 Ivy Ave.	McAllen	TX	78501	john_gutierrez@mcallen.net		✓
11	Alma Solis	City of McAllen	1300 Houston Ave.	McAllen	TX	78501	asolis@mcallen.net	956-681-1300	✓
12	Ovidlo Castillo	City of Pharr	118 S. Cage	Pharr	TX	78577		956-702-5321	✓
13	Jeffrey Erickson	Erickson Construction	3520 Buddy Owens	McAllen	TX	78504	jeffrey_erickson@sbcglobal.net	956-631-9789	
14	Frank Sanchez	Frank Sanchez Construction	3612 Agusta	McAllen	TX	78503	frasan1969@yahoo.com	956-905-5261	
15	Gumercindo Ortega	Ortega Engineering PLLC.	413 W. Nolana Ste 1	McAllen	TX	78504	ortegaeng@rgv.rr.com	956-618-1111	

Presented by Kathy McKelvey
September 14, 2009

IC3 - Tyler

	Name of Attendant	Company/Organization	Mailing Address	City	State	ZIP	E-Mail Address	Phone #
1	Dale Welch	Dale Welch Builders Inc.	11365 Cr. 167	Tyler	TX	75703	dwelch2991@aol.com	903-509-1950
2	Bernie Smith		3951 Pin Oak Rd.	Gilmer	TX	75645	brsmith@smithutopia.com	903-734-6759
3	Donnie Mitchell	Tree Inspector	13020 Shawntae Ln.	Tyler	TX		dminspector@att.net	903-534-6564
4	Mark Miears	City of Tyler	423 W. Ferguson	Tyler	TX	75702	mmiears@tylertexas.com	903-531-1154

Presented by Ed Dryden
June 3, 2009

IC3 - Abilene

	Name of Attendant	Company/Organization	Mailing Address	City	State	ZIP	E-mail Address	Phone Number
1	Ed Dryden	City of Arlington/ESL					Ed.Dryden@Arlingtontx.gov	817-459-6521
1	Van Watson	City of Abilene	555 Walnut St.	Abilene	TX	79604	van.watson@abilenetx.com	325-676-6486
2	David Marshall	City of Abilene	555 Walnut St.	Abilene	TX	79604	david.marshall@abilenetx.con	325-676-6276
3	Dwayne Williams	City of Abilene	555 Walnut St.	Abilene	TX	79604	dwayne.williams@abilenetx.cc	325-676-6352
4	Eddie Mitchell	City of Abilene	555 Walnut St.	Abilene	TX	79604	eddie.mitchell@abilenetx.com	325-676-6275
5	Charles W. Dyer	City of Abilene	555 Walnut St.	Abilene	TX	79604	dyer.toby@abilenetx.com	325-676-6274
6	Scotty Jones	City of Abilene	555 Walnut St.	Abilene	TX	79604	scotty.jwes@abilenetx.com	325-676-6320
7	Gary Boyd	City of Abilene	555 Walnut St.	Abilene	TX	79604	gary.boyd@abilenetx.com	325-676-6354
8	Shawn Earl	City of Abilene	555 Walnut St.	Abilene	TX	79604	shawn.earl@abilenetx.com	325-676-6397
9	Mike Ward	Mike Ward Custom Homes	4466 Iberis Rd	Abilene	TX	79601		325-698-8993
10	Don Faulkner	Don Faulkner Construction	4849 Autet	Abilene	TX	79606	DFCAbilene@att.net	325-673-8171
11	Anthony McColum	McColum Built Homes, Inc.	PO Box 7014	Abilene	TX	79608	MCBHI@clearwire.net	325-676-3935
12	Keith Rains	Habitat for Humanity	101 Fulwiler Rd	Abilene	TX	79603	Krains@abileneHabitat.org	325-670-0489
13	Bob Bein		1217 Canterbury	Abilene	TX	79602		325-673-9221
14	Jesse Evans	J&T Legend Homes Abilene LLC	PO Box 6178	Abilene	TX	79608		325-260-8282
15	Ruppert Ranger	Tittle Luther Partnership	340 Beach St.	Abilene	TX	79601	rranger@tlp.architecture.com	325-673-8178
16	Rodney Fletcher	City of Abilene	PO Box 60	Abilene	TX	79604	rodney.fletcher@abilenetx.coi	325-676-6271
17	Bill Newman	BMC West/Abilene Lumber		Abilene	TX		willienewman@gmail.com	325-665-8770
18	Frank Berrymow	City of Abilene	555 Walnut St.	Abilene	TX	79605	frank.berryman@abilenetx.coi	325-676-6353

Presented by Kathy McKelvey
September 17, 2009

IC3 - Houston

	Name of Attendant	Company/Organization	Mailing Address	City	State	ZIP	E-Mail Address	Phone #
1	Mike R. Baldwin	City of Houston	13535 Sharpbill Dr.	Houston	TX	77083	mbaldwin9@comcast.net	281-879-4550
2	Billy Coble	City of Houston	3300 Main Street	Houston	TX	77002	billy.coble@cityofhouston.net	713-535-7762
3	Ray Harmer	City of Houston	3300 Main Street	Houston	TX	77002	ray.harmer@cityofhouston.net	713-535-7730
4	William B. Pirooz	City of Houston	3300 Main Street	Houston	TX	77002	bill.pirooz@cityofhouston.net	713-535-7796
5	Cheryl A. Daniels	City of Houston	3300 Main Street	Houston	TX	77002	cheryl.daniels@cityofhouston.net	713-535-7763
6	Henry Rivers	City of Houston	3300 Main Street	Houston	TX	77002	henry.rivers@cityofhouston.net	713-535-7335
7	Alex Carreno	City of Houston	3300 Main Street	Houston	TX	77002	alex.carreno@cityofhouston.net	713-535-7769
8	Robert Voigt	City of Houston	3300 Main Street	Houston	TX	77002	robert.voigt@cityofhouston.net	713-535-7730
9	Judy Walton	City of Houston	3300 Main Street	Houston	TX	77002	judy.walton@cityofhouston.net	713-535-7541
10	Rebecca W. Tinnell	City of Houston	3300 Main Street	Houston	TX	77002	rebecca.tinnell@cityofhouston.net	713-535-7543
11	James Flack	City of Houston	10555 Fondren Apt	Houston	TX	77096	james.flack@cityofhouston.net	713-535-7854
12	Sheila Blake	City of Houston	3300 Main Street	Houston	TX	77096	sheila.blake@cityofhouston.net	713-535-7525
13	Richard Vrana	City of Houston	3300 Main Street	Houston	TX	77096	richard.vrana@cityofhouston.net	713-535-7645

Presented by Kathy McKelvey

IC3 CATEE 10-14-09

#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Rhys Davis	ccrd Partners	808 Travis, Suite 200	Houston	TX	77002	rhysd@ccrd.com		✓
2	Ibis Garcia	Energy Sense	5634 Sweetbriar	Houston	TX	77017	ibis.garcia@mascocs.com		✓
3	Jeremy Moureau	Energy Sense	5634 Sweetbriar	Houston	TX	77017	jeremy.moureau@mascocs.com		✓
4	Carmen Nava-Fischer	St. Phillip's College	1801 Martin Luther King Dr., Natural Sciences Bldg., Room 214-E	San Antonio	TX	78203	cnava-fischer1@alamo.edu		✓

Presented by Ed Dryden

August 20, 2009

IC3 - Mansfield

	Name of Attendant	Company/Organization	Mailing Address	City	State	ZIP	E-Mail Address	Phone #
1	Sana Touma	City of Mansfield	1200 E. Broad Street	Mansfield	TX	76063	sana.touma@ci.mansfield.tx.us	817-276-4277
2	Robert Chatham	City of Irving	825 W. Irving Blvd	Irving	TX	75060	rchatham@cityofirving.org	972-721-4888
3	Willie Lee Stevenson	City of Cleburne	10 N. Robinson	Cleburne	TX	76033	willie.stevenson@cleburne.net	817-556-8801
4	James Williams	City of Benbrook	911 Winscott Rd.	Benbrook	TX	76126	jwilliams@cityofbenbrook.com	817-249-3000
5	Joel Huff	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	jeol.huff@cityofcarrollton.com	972-466-5752
6	Billy McMahon	City of Carrollton	1945 E. Jackson Rd.	Carrollton	TX	75006	billy.mcmahon@cityofcarrollton.com	214-546-0155
7	Terri Carter	City of Mansfield	1200 E. Broad Street	Mansfield	TX	76063	terri.carter@mansfield-tx.gov	817-276-4230
8	Paul Coker	City of Mansfield	1200 E. Broad Street	Mansfield	TX	76063	paul.coker@mansfield-tx.gov	817-276-4223
9	John Shannon	City of Rockwall	385 S. Goliad St.	Rockwall	TX	75087	Jshannon@rockwall.com	972-772-6481
10	John Ankrum	City of Rockwall	385 S. Goliad St.	Rockwall	TX	75087	jankrum@rockwall.com	972-772-6774
11	Chad Joyce	Town of Pantego	1614 South Bowen Rd.	Pantego	TX	76013	cjoyce@townofpantego.com	817-860-1681
12	Dale McKendrick	Town of Little Elm	100 W. Eldorado Blvd	Little Elm	TX	75068	dmckendrick@littleelm.org	214-925-0457
13	Jack Foster	Town of Little Elm	100 W. Eldorado Blvd	Little Elm	TX	75068	jfoster@littleelm.org	214-975-0458
14	Lawrence Crow	City of Irving	825 W. Irving Blvd	Irving	TX	75060	lcrow@cityofirving.org	972-721-4875
15	Morris Cowden	City of Mansfield	1200 E. Broad Street	Mansfield	TX	76063	morris.cowden@ci.mansfield.tx.us	817-276-4200
16	Wendell Thomas	City of Mansfield	1200 E. Broad Street	Mansfield	TX	76063	wendell.thomas@ci.mansfield.tx.us	817-276-4200

Presented by Kathy McKelvey

February 20, 2009

IC3 - Mesquite

	Name of Attendant	Company/Organization	Mailing Address	City	State	ZIP	E-Mail Address	Phone #
1	Darren Ennis	City of Mesquite	1515 N. Galloway	Mesquite	TX	75149	dennis@ci.esquite.tx.us	972-329-8318
2	Larry Ewing	City of Mesquite	1515 N. Galloway	Mesquite	TX	75149	lewing@ci.mesquite.tx.us	972-216-6373
3	Keith Smith	City of Mesquite	1515 N. Galloway	Mesquite	TX	75149	ksmith@ci.esquite.tx.us	972-329-8724

Presented by Ed Dryden and Kathy McKelvey

January 23, 2009

IC3 - Missouri City

	Name of Attendant	Company/Organization	Mailing Address	City	State	ZIP	E-Mail Address	Phone #
1	Stephanie Montgomery	Mikayla Architects	48616 Creekbend Dr	Houston	TX	77035	mikayla27@juno.com	
2	Rick Korger	Ryland Homes	5353 W. Sam Houston Pkwy N. #100	Houston	TX	77041	rkorger@ryland.com	281-389-4470
3	Kristy Leblanc	City of Sugarland	2700 Town Center Blvd N.	Sugarland	TX	77479	klblanc@sugarlandtx.gov	281-275-2282
4	James Hickman	James Hickman Inspections	3214 Federal	Pasadena	TX	77504		713-941-3737
5	Ignacio Moteno	City of Missouri City	1522 TX Pkwy	Missouri City	TX	77489	imoreno@missouricitytx.gov	281-403-8554
6	Wesley Clendennen	City of Missouri City	1522 TX Pkwy	Missouri City	TX	77489	wclendennen@missouricitytx.gov	
7	Jaime Rodriguez	City of Missouri City	1522 TX Pkwy	Missouri City	TX	77489	jrodriguez@missouricitytx.gov	832-885-4389
8	Yolanda Ford	City of Missouri City	1522 TX Pkwy	Missouri City	TX	77489	yford@missouricitytx.gov	832-746-3504
9	Gus Garcia	City of Missouri City	1522 TX Pkwy	Missouri City	TX	77489	ggarcia@missouricitytx.gov	
10	Lalo Plores	City of Missouri City	1522 TX Pkwy	Missouri City	TX	77489	lplores@missouricitytx.gov	281-403-8552

Presented by Kathy McKelvey

IC3 Houston Morning - 9-16-09

#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Jennifer Roberson	City of Houston Code Enforcement	3322 Yellowstone Blvd. Apt 2006	Houston	TX	77021	jennifer_roberson_jja@yahoo.com	832-788-9728	✓
2	Kenneth Smyers	City of Houston Code Enforcement	2106 Fountain Dr.	Sugarland	TX	77478	kenneth.smyers@cityofhouston.net	713-535-7992	✓
3	Gretchen Hinze	City of Houston Code Enforcement	1123 E. Belgravia Dr.	Pearland	TX	77584	DYtriprYEA@hotmail.com	713-436-3484	✓
4	Daniel Slack	City of Houston Code Enforcement	10722 Ashcroft	Houston	TX	77096	daniel.slack@cityofhouston.net	713-535-7544	✓
5	Michael Helmlinger	City of Houston Code Enforcement	5819 McKnight St.	Houston	TX	77035		713-721-6566	✓
6	Walter Scott	City of Houston	2918 Mission Valley Dr.	Missouri City	TX	77459	walterscott4@sbcglobal.net	832-758-6079	✓
7	Carlos Martinez	City of Houston	3300 Main St.	Houston	TX	77002	carlos.martinez@cityofhouston.net	713-535-7716	✓
8	Ralph Bowden	City of Houston	3300 Main St.	Houston	TX	77002	ralph.bowden@cityofhouston.net	713-535-7703	✓
9	Magdalena Prus	City of Houston	3300 Main St.	Houston	TX	77002	magdalena.prus@cityofhouston.net	713-535-7719	✓
10	Freddie Ellis	City of Houston	3300 Main St.	Houston	TX	77002		713-535-7672	✓
11	Lisa Brown	City of Houston	3300 Main St.	Houston	TX	77002	lisa.fleming@cityofhouston.net	713-535-7856	✓
12	Larry LaHaie	City of Houston	17202 Stamford Oaks Dr.	Tomball	TX	77377	larry.lahaie@cityofhouston.net	713-535-7534	✓
13	Wilbert Cernosek	City of Houston	5822 Bitternut Dr.	Houston	TX	77092	will.cernosek@cityofhouston.net	713-962-7047	✓

Presented by Ed Dryden and Kathy McKelvey
February 27, 2009

IC3 - Wichita Falls

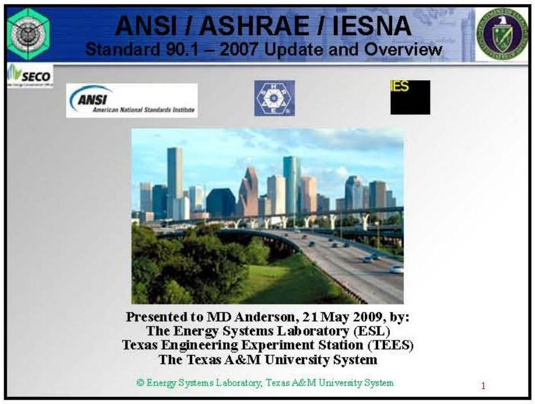
	Name of Attendant	Company/Organization	Mailing Address	City	State	ZIP	E-Mail Address	Phone #
1	Alan Hinson	Dennis Company	PO Box 4815	Wichita Falls	TX	76374	alan@denniscompanyhomes.com	940-692-0410
2	Mark Zug	Mr Eco Friendly Foam Insulation	1609 Grant	Wichita Falls	TX	76309	crossworksonline@juno.com	940-704-9371
3	Patrick Hearn	David Cohn Plumbing	1025 Wellington	Wichita Falls	TX	76305	hearn.patrick@gmail.com	940-704-9577
4	Tim Thomason	T-square Construction, Inc.	723 West Texas St.	Iowa Park	TX	76367	woodchuck21@sbcglobal.net	904-704-5002
5		David Bedingfield Homes	905 Bowman Rd	Wichita Falls	TX	76308	bedingfield905@aol.com	940-733-0348
6		Homes of Destination	4001 Cailfield Rd	Wichita Falls	TX	76308	keeterin@aol.com	940-692-6290
7	Charles Barr	Charles Barr Homes	PO Box 3051	Wichita Falls	TX	76301	cbarr@sw.rr.com	940-696-1924
8	Shirley Barr	Charles Barr Homes	PO Box 3051	Wichita Falls	TX	76301	shirleyb@sw.rr.com	940-696-1924
9	Stan Mountain	Stan Mountain Construction	7555 HWY 258 W.	Iowa Park	TX	76367	smountain@windstream.net	940-631-2258
10	Doug McCulloch	Douglas Custom Homes, Inc.	4131 Southwest Pkwy	Wichita Falls	TX	76308	tdouglasmc@aol.com	940-704-1461
11	Bobby G. Rowland	Rowland & Donnell Homes	4090 Regent Drive	Wichita Falls	TX	76308	bobby@rowland-donnell.com	940-692-1904
12	Don Hatley	Donco Construction	PO Box 9010	Wichita Falls	TX	76308	donco@wf.net	940-692-6997
13	Bobby Teague	City of Wichita Falls	1300 7th St., Rm. 401	Wichita Falls	TX		bobby.teague@cwftx.net	940-761-7460
14	Manuel Soto	City of Wichita Falls	1300 7th St., Rm. 401	Wichita Falls	TX		manuel.soto@cwftx.net	940-761-6828

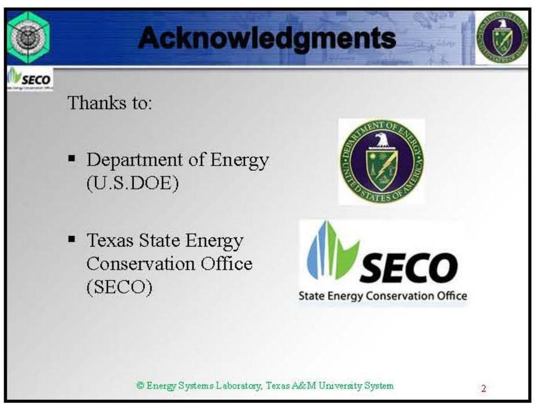
Presented by Kathy McKelvey

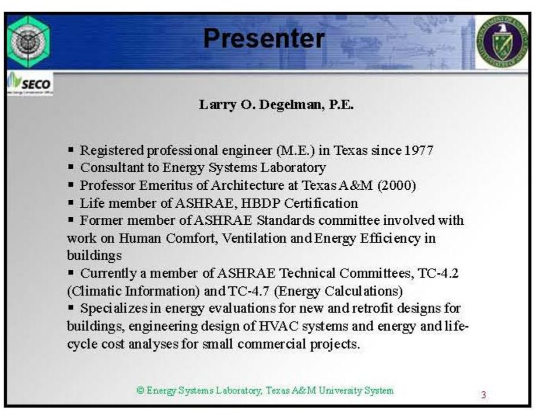
IC3 Houston Afternoon - 9-16-09

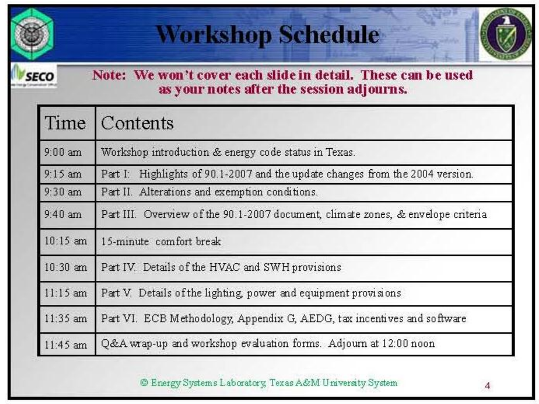
#	Name	Company/ Organization	Mailing Address	City	State	Zip	Email	Phone #	CEU Req.
1	Michael Martinez	HG Engineering	15693 Glen Chase Dr.	Houston	TX	77075	mm@hgeconsulting.com	281-856-7682	
2	Helen Peter	Peter/Miller Architects	PO Box 1614	Stafford	TX	77497	pencil@pdg.net	281-240-4106	
3	Carol Stallings	CJ Permits	6627 Liberty Valley Dr.	Katy	TX	77449	permitjc@yahoo.com	281-660-1319	
4	Ellas Hourani	EFH Consulting Engineers	2906 Carrolton St.	Houston	TX	77023	efh7@aol.com	713-926-2490	
5	J. Allan Hensley Jr.	Brickland Homes	14520 Wunderlich Ste 100	Houston	TX	77069	allan@bricklandhomes.com	281-893-5689	✓
6		Site Prep	3033 Chimney Rock, Ste 425 MB 102	Houston	TX	77056	harvywilliams@gmail.com	713-459-0359	
7	Steve Rudin	Loyd Russel Homes	1934 W. Gray, Suite 301	Houston	TX	77019	Steve@lodyrusselhomes.com	281-932-4942	
8	Jeni O'Quinn	Roesler Assoc. Inc. Architects	19135 W. Sawtooth Canyon	Tomball	TX	77377	joquinn26@att.net	832-453-9694	✓
9	Matt Roesler	Roesler Assoc. Inc. Architects	817 W. 32nd St.	Houston	TX	77018	aroearch@earthlink.net	713-862-8655	✓
10	Hy Applebaum	R&A Architects	5243 Lymbar Dr.	Houston	TX	77096	ra.arch@sbcglobal.net	713-981-7315	✓
11	Susan Quave	Diversified Thermal	6727 Signat	Houston	TX	77041	susan@diversified-thermal.com	281-850-2086	
12	Sharon Attra	Diversified Thermal	6727 Signat	Houston	TX	77041	sharon@diversified-thermal.com	713-896-6801	
13	Harry Brooks	Accent Group Arhcitects	2719 N. Peach Hollwo Circle	Pearland	TX	77584	hlbjr5239@sbcglobal.net	832-444-0948	✓
14	Brian Abby	Hensley Lamkin Rachel	10375 Richmond Ave. Ste 1440	Houston	TX	77042	babby@hlrinc.net	713-781-1400	
15	Robert Dudley	Curtis & Windham Architects	3815 Montrose Blvd. Suite 100	Houston	TX	77006	robert@curtiswindham.com	281-660-4212	
16	Edward Robinson	Professional Engineering Insp.	PO Box 666	Friendswood	TX	77549	mail@profengineering.com	713-664-1264	✓
17	Scot Harris	Preston Wood & Associates, LLC	1113 Vine St. Suite 240	Houston	TX	77002	scot@jackprestonwood.com	713-522-2724	
18	John Rogers	Rogers & LaBarthe Architects	2017 W. Gram Suite 7	Houston	TX	77019	info@rogerslabarthe.com	713-522-8805	✓
19	Kenneth Gau	WSP Flack & Kurtz	2424 Wilcrest Dr., Suite 200	Houston	TX	77042	ken.gau@wspfk.com	713-785-1311	✓
20	Roy Hamm	Hamm's Mechanical	1134 Union Valley	Pearland	TX	77581	roy.1@sbcglobal.net	832-289-3335	✓
21	Chuck Farnham	Diversified Thermal	6727 Signat	Houston	TX	77041	chuck@diversified-thermal.com	713-896-6801	✓
22	Carlos Bales	Diversified Thermal	6727 Signat	Houston	TX	77041	carlos@diversifiled-thermal.com	713-896-6801	✓
23	Ginny Knight Gribble	Raymond Engineering	32938 Tamina Rd., Ste 101	Magnolia	TX	77354	ginny.gribble@raymondengineering.com	281-440-7211	
24	David McLemore	Raymond Engineering	32938 Tamina Rd., Ste 101	Magnolia	TX	77354	david.mclemore@raymondengineering.com	281-440-7211	
25	Floyd Worsley Sr.		11642 Briar Rose	Houston	TX	77077	floyd.worsley@att.net	281-627-4135	
26	David Beck	Hordce Homes	1241 Peden St.	Houston	TX	77006	dbeck@hordce-homes.com	281-960-8778	
27	Richard Buendia	Texas Precision Real Estate Insp.	13280 NW Fwy Ste. F	Houston	TX	77040	texasprecision@msn.com	832-606-4799	✓
28	Artemio Ayala	Art Ayala Architects, Inc.	1504 Rothwell	Houston	TX	77002	aaainc@sbcglobal.net	713-224-7390	✓
29	Frank Guy	Energy Efficient Insulation	4307 Spring Stuebner	Spring	TX	77379	fguy@eeitexas.com	713-715-9623	✓
30	Jerry Dan Roberson	Energy Efficient Insulation	4307 Spring Stuebner	Spring	TX	77389	droberson@eeitexas.com	281-353-7007	
31	Carlos Umanzor	Universal Cooling & Heating Inc	13331 Veterans Memorial # T	Houston	TX	77014	universalcooling@aol.com	281-580-7271	
32	Jay Leggett	Lighting Design Solutions, LLC	6418 Ferris Dr., Suite 2	Houston	TX	77081	jay@lightingdesign.pro	713-459-0094	✓
33	Jim K. Shroff	JSA Consulting	1201 Demaret Lane	Houston	TX	77055	ashroff@flash.net	713-461-7140	✓

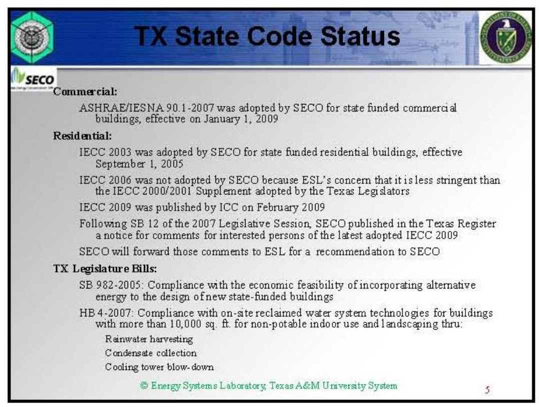
The ASHRAE 90.1-2007 Workshop includes a brief overview of SB 5 and a summary of the relationship between ASHRAE 90.1 and the Commercial provisions of the IECC.

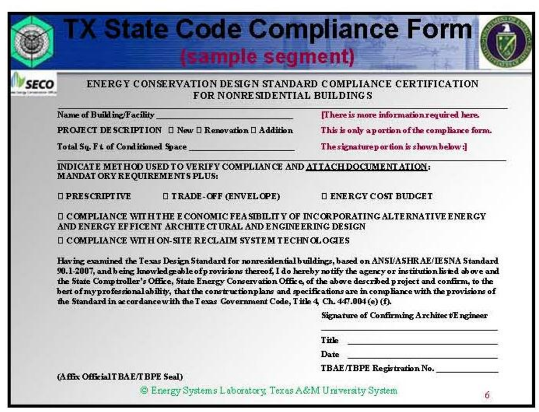












TX State Code Info Sources

State Website(s):

State Energy Conservation Office: **http://www.seco.cpa.state.tx.us**
Texas Energy Systems Lab: **http://esl.eslwin.tamu.edu/senate-bill-5.html**
The Texas Energy Partnership: **http://www.texasenergypartnership.org/**

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Part I.

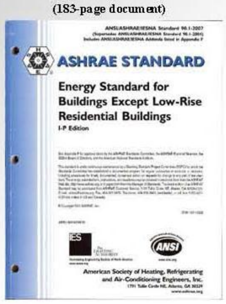
Part I: Highlights of 90.1-2007 and the update changes from the 2004 version.

 8

Key Features of 90.1-2007

- **It replaces ANSI/ASHRAE/IESNA Standard 90.1-2004, based on 44 Addenda.**
- **It will be the reference standard for the 2009 IECC.**
- **It is the professional "standard of care" set by ASHRAE consensus.**
- **Revised format: Re-structured more like a code, with consistent numbering scheme.**
- **Climate zones:**
  - ➢ **Defined geographically by county lines, not by individual city or climatic Degree Days.**
  - ➢ **Metropolitan areas kept together.**
  - ➢ **IECC (2004 update) was changed to use the same zones.**

(183-page document)



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Section 1 - Purpose

The purpose of this standard is to provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings.

- **"Low-rise residential" is defined as single-family homes, manufactured housing, and other residential structures that are less than 4 stories above grade.**

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Section 2 – Scope

- **Provisions apply to:**
  - **Envelope:**
    - ➢ **if heated by a heating system with an output capacity ≥ 3.4 Btu/h-ft² or**
    - ➢ **if cooled by a cooling system with a sensible output capacity ≥ 5 Btu/h-ft²**
  - **Virtually all mechanical, power, and lighting systems are covered**

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Section 3 – Definitions

- Conditioned space:
  - ➢ cooled by a cooling system with a sensible output capacity >5 Btu/h-ft²
  - ➢ heated by a heating system with an output capacity ≥ Table 3.1
  - ➢ indirectly conditioned space – adjacent to conditioned space but neither heated nor cooled
- Semiheated space: heated at ≥ 3.4 Btu/h-ft², but not classified as conditioned.
- Unconditioned space: e.g., crawl spaces, attics, etc.

Table 5-G—Heated Space Criteria

(This is Table 3.1 in the Standard)

Heating Output (Btu/h·ft²)	*Climate Zone*
5	1 and 2
10	3
15	4 and 5
20	6 and 7
25	8

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Section 3 – Definitions

Abbreviations
Acronyms

Some useful terms:
•EER = Btu/watt-hr. (at approx. 95F)
•Kw/ton=12/EER
•SEER=Btu out/watt-hr. (clg seasonal)
•COP= Btu out/Btu in (~efficiency)
•EER= 3.4 * COP
•HSPF=Btu out/watt-hr. (htg seasonal)
•IPLV=Integrated part load value = could be COP or EER at partial load.

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Space Definitions

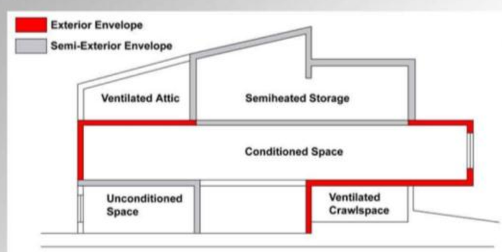

Figure 5-5 Space Definitions

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Envelope Definitions (Section 3.2)

- Exterior envelope separates
  - "Conditioned space" from exterior
    - ➢Cooled by systems with a sensible output capacity equal to or greater than 5 Btu/h•ft² of floor area
    - ➢Heated by systems with output capacity relative to floor area that is equal to or greater than the criteria in Table 3.1 (varies from 5 to 25 Btu/h•ft², depending on climate zone.)
- Semi-exterior envelope separates
  - Conditioned from "Semi-heated" space or unconditioned space
    - ➢Has a heating system with a capacity ≥ 3.4 Btu/h•ft² (10 W/m²) of floor area but is under the criteria in Table 3.1)
  - Semi-heated space from either unconditioned or the exterior.

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Administration & Enforcement (Section 4.1.1)

Standard 90.1 applies to:
- New buildings
- Additions to existing buildings*
- Alterations to existing buildings*
- Replacement of parts of existing bldgs*
- Changes in HVAC*

* Additions & alterations permit trade-offs and have other exceptions.

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Compliance Paths

Building System		Compliance Options	
Envelope	Mandatory Provisions (required for most compliance options)	Prescriptive Option	Energy Code Compliance
HVAC		Trade Off Option	
SWH		Energy Cost Budget	
Power		Simplified	
Lighting			
Other			

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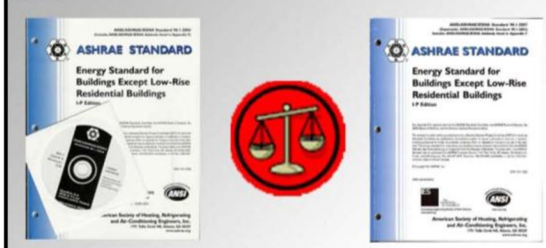
Changes since 90.1-2004



90.1-2004 VS. 90.1-2007
(while 90.1-2010 is already being written)

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Spotlight the Main Changes Since 90.1-2004

Most significant increases in stringency:

Envelope:

- Fenestration U-Factor requirements in 90.1-2007 are around 38% lower than those in 2004.
- Fenestration SHGC's are about equal in nonresidential bldgs but about 43% lower for residential bldgs.
- SHGC's apply to all exposures and are no longer exempt the north orientation as they were in the 2004 versions. On the north wall, the reduction in SHGC is around 59% when compared to 2004.
- Roofs with attics and roofs with above-deck insulation have U-factor requirements are 20% to 24% lower. Wall U-factor requirements remain about the same.

Mechanical:

- Demand control ventilation (DCV) in the 2007 version is now required for any zone with an area > 500 ft² and the design occupancy > 40 people/1000 ft² where the HVAC system is served by either an air-side economizer, an automatic modulating control of the OSA dampers, or a design outdoor airflow > 3,000 cfm. (Section 6.4.3.9.)
- VAV fan power limitations in the 2007 version will now apply to individual fan motors of 10 h.p. or greater, whereas this was 30 h.p. or greater in the 2001 version, and 15 h.p. or greater in the 2004 version.

Lighting:

- Interior lighting power limits have not changed between versions 2004 and 2007, but are significantly more restrictive than the 2001 version. The 32 whole-building lighting power densities (LPD) values are an average of 25% more stringent. For the 91 space types, the LPD's average about 29% less than the 2001 version. Though this will likely require more careful lighting design, it probably represents the largest single energy savings of all the changes made in the evolution from version 2001 to 2007 of the standard.

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Changes since 90.1-2004 (cont.)

Other updates with less impact on stringency:

General:

- New technical requirements and stringency levels are presented in a more consistent format, making them easy to find and apply to building designs. With a standard that is easier to use, it is likely to be used more, resulting in more energy being saved.

Appendix G (Performance Rating Method):

- This is a section that adds new information to rate the energy efficiency of building designs that exceed the minimum requirements (i.e., the 90.1 Standard requirements.) Appendix G provides guidance that is beneficial to HVAC designers who are trying to achieve the required points for either a Silver or Gold Leadership in Energy and Environment Design (LEED) certification of a facility.

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Changes since 90.1-2004 (cont.)

Climate Zones:

Both the 2004 and 2007 versions now use just 8 climate zones (down from 26 in version 2001.) The lower number of primary climate zones resulted in a reduction of the number of tables of building envelope criteria, thus making the standard easier to use. This results in simplification while minimizing the changes in the building envelope criteria.

Envelope:

For cool roofs:

In the 2004 version, for high albedo roofs, there was a simple table of roof U-factor multipliers (Table 5.5.3.1) that contained only 4 values. In the 2007 version, this has been replaced by a much more comprehensive table that shows actual U-factor limits that substitute for the roof U-factors found in Table 5.5-x. For climate zones found in Texas, this change has maintained approximately equal U-factors for the roofs over attics, but has permitted an increase in U-factors by around 8% for other roofs.

Envelope Trade-Off:

The EnvStd computer program is used in conjunction with the Building Envelope Trade-Off compliance method and the selection and application of energy simulation programs used in conjunction with the energy cost budget method of compliance. **This software is included on a CD that comes with the printed 90.1 User's Manual.**

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Changes since 90.1-2004 (cont.)

Mechanical:

The mechanical section has been reorganized to make it easier to read. New climate zone data further simplifies many of the mechanical requirements from economizer requirements to duct insulation.

- **Energy efficiencies** are increased for fans, single package vertical units and three-phase air-cooled air conditioners. Revisions to Tables 6.8.1A (AC) and 6.8.1B (HP) reflect changes in DOE Efficiency Standards for unitary and packaged equipment.
- **Dead Bands:** Removes exemption from dead band requirements for data centers (6.4.3.1.2 and 6.4.3.7).
- **Off-hour Controls:** Removes exception for off hour controls (6.4.3.2) for hotel/motel guestrooms.
- **Ventilation Standards:** Updates references to Standard 62.1.
- **Boilers:** Updates boiler test procedure. Increase in boiler efficiency requirements (Table 6.8.1F).
- **Cooling Towers:** Changes to the rating procedures for cooling towers (Table 6.8.1G).
- **Furnaces:** Adds IID (Intermittent Ignition Devices) and dampers or power venting to furnaces and unit heaters (Table 6.8.1E), as of 8 August 2008, in order to comply with the Energy Policy Act of 2005.
- **Humidity Controls:** Under Section 6.4.3.7 (Simultaneous heating and cooling for dehumidification), added an exception for spaces that require specific humidity levels (museums or hospitals) if approved by authority having jurisdiction.
- **Fan Power:** Significant changes to the fan power limitations (6.5.3). Two methods of compliance: (1) by motor nameplate HP or (2) by fan system brake HP (BHP) with a number of fan power credits applied in the calculation of BHP. Fan hp and bhp must be indicated on the design documents.
- **Motors:** New section added on motor oversizing limitations (§ 6.5.3.1.2)
- **Economizers:** Economizer requirements are now specified by climate zone number.
- **Duct insulation:** Versions 2004 & 2007 require insulation on essentially all return air ducts.

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Changes since 90.1-2004 (cont.)

Lighting changes (mostly in LPD values):

- The LPD limitations are the same as the 2004 version, but will save from 25% to 29% of the energy use by lights from the 2001 version.
- A new exterior lighting section includes specific lighting power limits for a variety of exterior applications.
- Internally illuminated Exit Signs now shall not exceed 5W per face.
- LED lamps okay, but most incandescent lamps will not be acceptable.
- Power limits added for exterior lighting categories (e.g. – walkways, parking lots, ATMs).

Less human intervention control.

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Part II.

Part II: Alterations and exemption conditions.

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Alteration Conditions

- Altered components must meet new construction requirements, but with various exceptions for:
  - ➢Envelope
  - ➢HVAC
  - ➢Water Heating
  - ➢Lighting
- Applies to affected components only!
- Cosmetic treatments do not need to be considered….unless they expose energy components
- Allows energy trade-off compliance method in addition to prescriptive

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What about renovations?

- Historically, energy code compliance has been focused on new construction.
- Alterations/Remodeling/Additions are now covered in major energy codes **(not repairs.)**
  - ➢ASHRAE 90.1 since 1999
  - ➢IECC since 2000
- Application and Enforcement depends on local or State Code officials.

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Additions / Alterations
(Bottom Line: no increase in energy use)

- Addition: an increase in floor area or building height
  - ➢ Compliance same as new bldgs, except ECB can be used by including the ***existing portion.***
- Alteration: replacement of parts of a building or its systems. (Maintenance, repair, or service are not considered as alterations)

Exception: Compliance w/ sections 5-10, except "National Registry of Historic Places" or total energy consumption ≤ equivalent design that complies with sections 5 through 10.

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Envelope Exceptions

The following need not comply:

- Storm windows
- Glazing replacement only (≤ U/SHGC)
- Window replacement (< 25% and = U/SHGC)
- Insulation cavity already filled (R=3/inch) or unexposed (inaccessible)
- Roof membrane only or below deck insulation
- Vestibule requirements not applicable on door replacement

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HVAC Alterations

- New HVAC equipment, used as a replacement, shall comply w/ minimum efficiencies.
- New cooling systems to serve previously uncooled spaces shall comply with section 6.
- Alterations to HVAC shall not decrease economizer capabilities.
- New & replacement ductwork to comply w/ 6.4.4.1 (insulation) & 6.4.4.2 (leakage).
- New & replacement piping to comply with 6.4.4.1.

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Mechanical Exceptions

- Equipment modification or repair only (no increase in energy)
- Where compliance requires extensive revision to other systems
- Refrigerant change only
- Relocation of existing equipment
- Water Heaters, Ductwork, and Piping – where there is insufficient space to access.

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90.1 Lighting Exceptions

Replacement of less than 50% of luminaires in a "space"….but must not increase energy use.

Note: replacement of luminaire components only (lamp, ballast) does not constitute an alteration for compliance purposes. This is maintenance..

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Part III.

Part III: Overview of the 90.1-2007 document, climate zones & envelope criteria.

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The Document Structure

Sections in the document

1. Purpose
2. Scope
3. Definitions, Abbrev. & Acronyms
4. Administration and enforcement
5. Building envelope
6. HVAC
7. SWH
8. Power
9. Lighting
10. Other equipment
11. Energy Cost Budget (ECB)
12. Normative References

Appendices A – G

Technical Sections Outline

x.1 General – Scope & conditions
x.2 Compliance Paths
x.3 Simplified Building
x.4 Mandatory Provisions
x.5 Prescriptive Compliance Path
x.6 Alternative Compliance Path
x.7 Submittals – Drawings, manuals, labeling, etc.
x.8 Product Information – Equipment efficiencies, installation requirements, etc.

"Exceptions" are common and are stated under each requirement in the standard.

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Consistent Organization of Technical Sections

X.1 General – Scope, other special conditions
X.2 Compliance Paths
X.3 Simplified Building (**only used in HVAC**)
X.4 Mandatory Provisions
- Must be followed for all buildings.

X.5 Prescriptive Compliance Path
- Must be followed or traded-off **w/ ECB.**

X.6 Alternative Compliance Path (**only in section 5, Envelope, and section 9, Lighting**)
X.7 Submittals – Drawings, manuals, labeling, etc.
X.8 Product Information – Equipment efficiencies, installation requirements, etc.

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Section 5: Building Envelope Provisions

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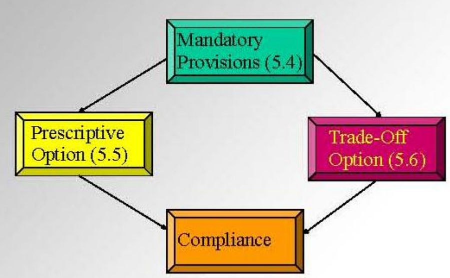
Envelope Compliance Paths (Section 5.2)



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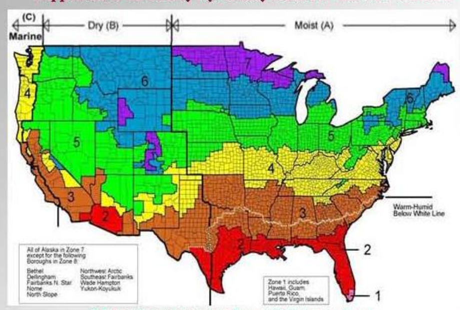
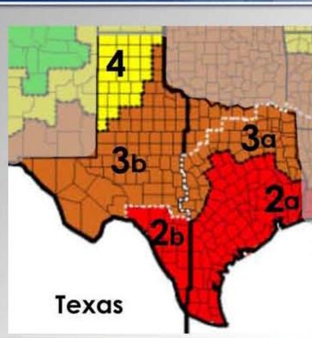
8 Climate Zones

Zones based on several climatic parameters: Locations are listed in Appendix B on county-by-county basis for the 50 US states.



Texas Climate Zones



Insulation not required for non-residential "mass walls" in locations below the "warm-humid" line.

Space-conditioning Categories (Section 5.1.2)

- Each space to be included in a category:
  - Nonresidential conditioned space, or
  - Residential conditioned space, or
  - Semiheated space
- Spaces are assumed to be conditioned at time of construction regardless of presence of HVAC.
- Spaces in climate zones 3-8 may be designated as ***semiheated or unconditioned*** only if approved as such by the ***building official***.

Building Envelope Sealing (Section 5.4.3.1)

Sealed, caulked, gasketed, or weather-stripped:

- **Joints around windows and doors**
- **Junctions between walls & foundations or roofs**
- **Openings at penetrations of walls, roofs, and floors**
- **Site-built fenestration and doors**
- **Building assemblies used as air ducts or plenums**
- **Any penetrations through vapor retarders**
- **All other openings in building envelope**

** No exceptions to the above

** No requirement for a continuous air barrier (housewrap)

Air Leakage - Fenestration and Doors (Section 5.4.3.2)

- NFRC 400
- Labeled and certified by manufacturer
- Glazed swinging entrance doors and revolving doors – not to exceed 1.0 cfm/ft^2
- All other products – not to exceed 0.4 cfm/ft^2
- Exceptions
  - Field-fabricated fenestration and doors
  - Garage doors – ANSI/DASMA 105

Air Leakage - Loading Dock Weatherseals (Section 5.4.3.3)

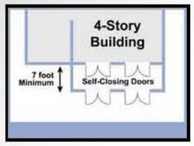
In climate zones 4-8

- Cargo doors and loading dock doors equipped with weatherseals
- To restrict infiltration when vehicles are parked in the doorway

Figure 5-H—Loading Dock Weatherseal

Air Leakage – Vestibules (Section 5.4.3.4)

- Required in
  - Climate Zones 3-4 for entrances in >4 story buildings or > 10,000 ft^2
  - Climate Zones 5-8 for entrances in buildings > 1000 ft^2
- Vestibules must have:
  - Self-closing doors
  - Interior and exterior doors not open at the same time
  - Distance between interior and exterior doors not < 7 ft when in closed position (remember ADA!)



Exceptions:
1. Revolving doors.
2. Climate zones 1&2.
3. "Non-entrance" doors that enter a space < 3000 ft^2 in any climate zones.

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Building Envelope Prescriptive Option (Section 5.5)

Window Wall Ratio (WWR) ≤ 40% of gross wall area *
Skylight-roof ratio ≤ 5% of roof area
Each envelope component must separately meet requirements of Table 5.5

- 8 criteria sets for different climate types:
  - Each set = single page that summarizes all prescriptive requirements
    - Insulation levels for roofs, walls and floors
    - Fenestration criteria

* Allowed up to 50% in 2004.

Or, alternatives are to use Trade-Off Option (Section 5.6) or the ECB Method (Section 11)

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Roof UF Requirements in Texas (Section 5.5.3.1)

[Some changes since version 2004]

Sample Cities from the 90.1 documents.	Climate Zone 2007 (just 3 zones total)	90.1-2004 roof UF attic / concrete deck Non-res.	Resi-dential	Semi-heated	90.1-2007 roof UF attic / concrete deck Non-res.	Resi-dential	Semi-heated
Brownsville, Harlingen, McAllen Corpus Christi, Galveston, Victoria, Houston, Huntsville, Beaumont, Port Arthur, San Antonio, Austin	2A	.034 .063	.027 .063	.081 .218	.027 * .048 *	.027 .048 *	.081 .218
Del Rio, Laredo	2B						
Dallas, Fort Worth, San Angelo, Waco	3A	.034 .063	.027 .063	.081 .218	.027 * .048 *	.027 .048 *	.053 * .173 *
Abilene, Big Spring, El Paso, Midland, Wichita Falls, Lubbock	3B						
Amarillo	4B	.034 .063	.027 .063	.081 .218	.027 * .048 *	.027 .048 *	.053 * .173 *

* Represents increased stringency between 2004 and 2007.

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Table 5.5-2, (Opaque elements) (Bldg Envelope Req'mts for Climate Zone 2 a,b)

TABLE 5.5-2 Building Envelope Requirements For Climate Zone 2 (A, B)*

Opaque Elements	Nonresidential Assembly Maximum	Nonresidential Insulation Min. R-Value	Residential Assembly Maximum	Residential Insulation Min. R-Value	Semiheated Assembly Maximum	Semiheated Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.218	R-3.8 c.i.
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-0.167	R-6.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.081	R-13.0
Walls, Above-Grade						
Mass	U-0.151[a]	R5.7 c.i.[a]	U-0.123	R-7.6 c.i.	U-0.580	NR
Metal Building	U-0.113	R-13.0	U-0.113	R-13.0	U-0.184	R-6.0
Steel-Framed	U-0.124	R-13.0	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.107	R-6.3 c.i.	U-0.087	R-8.3 c.i.	U-0.322	NR
Steel-Joist	U-0.052	R-19.0	U-0.052	R-19.0	U-0.069	R-13.0
Wood-Framed and Other	U-0.051	R-19.0	U-0.033	R-30.0	U-0.066	R-13.0
Slab-On-Grade Floors						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.450		U-0.500		U-1.450	

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Table 5.5-2, (Opaque elements)

Definition of Roof Construction Types

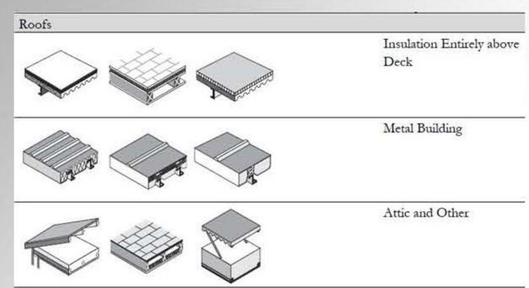

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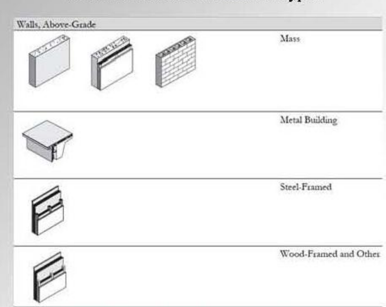
Table 5.5-2, (Opaque elements)

Definition of Wall Constructions Types



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Cool Roof U.F. Adjustment
(Section 5.5.3.1.1)

For High Albedo Roofs, there are new criteria for the roof UF requirements that are found a substitute table (Table 5.5.3.1.) that includes all 8 zones. High albedo is defined as "having a solar reflectance ≥ 0.7 and an emittance ≥ 0.75 *).

No adjustment is permitted if it is a ventilated attic of if the space is classified as semiheated.

* As tested by one of the specified ASTM methods.

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Roof U.F. Adjustment
(Section 5.5.3.1.1)

Another criterion for use of the high albedo table is if the roof achieves a Solar Reflective Index (SRI *) of 0.82. The criterion for an SRI of 0.82 is shown in the Table at the right.

* As tested by ASTM E1980.

Note: This Table 5-D is only found in the 90.1 User's Manual.

Table 5-D—Emittance and Reflectance Values to Achieve an SRI of 82

Emittance	Reflectance
0.10	0.810
0.15	0.800
0.20	0.790
0.25	0.785
0.30	0.775
0.35	0.765
0.40	0.760
0.45	0.750
0.50	0.740
0.55	0.730
0.60	0.725
0.65	0.715
0.70	0.705
0.75	0.700

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Table 5.5-2 (Fenestration)
(U.F. & SHGC req'mts in climate zone 2 a,b)

UF and SHGC ** Requirements

TABLE 5.5-2 Building Envelope Requirements For Climate Zone 2 (A, B)*

Fenestration	Nonresidential Assembly Max. U	Nonresidential Assembly Max. SHGC	Residential Assembly Max. U	Residential Assembly Max. SHGC	Semiheated Assembly Max. U	Semiheated Assembly Max. SHGC
Vertical Glazing, 0%–40% of Wall						
Nonmetal framing (all)[b]	U-0.75	SHGC-0.25 all	U-0.75	SHGC-0.25 all	U-1.20	SHGC-NR all
Metal framing (curtainwall/storefront)[c]	U-0.70		U-0.70		U-1.20	
Metal framing (entrance door)[c]	U-1.10		U-1.10		U-1.20	
Metal framing (all other)[c]	U-0.75		U-0.75		U-1.20	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}-1.98	$SHGC_{all}$-0.36	U_{all}-1.98	$SHGC_{all}$-0.19	U_{all}-1.98	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-1.98	$SHGC_{all}$-0.19	U_{all}-1.98	$SHGC_{all}$-0.19	U_{all}-1.98	$SHGC_{all}$-NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}-1.90	$SHGC_{all}$-0.39	U_{all}-1.90	$SHGC_{all}$-0.27	U_{all}-1.90	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-1.90	$SHGC_{all}$-0.34	U_{all}-1.90	$SHGC_{all}$-0.27	U_{all}-1.90	$SHGC_{all}$-NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}-1.36	$SHGC_{all}$-0.36	U_{all}-1.36	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-1.36	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-NR

** SGHCs have a major change from 90.1-2004: These now apply to all orientations, including North

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Solar Heat Gain Coefficient (SHGC) (Section 5.8.2.5)

"The SHGC for the overall fenestration area shall be determined in accordance with NFRC 200."

Exceptions – one of these alternatives:

- **SC (from NFRC 300) x 0.86 is acceptable for overall fenestration area.**
- **SHGC of center of glass (spectral data file per NFRC 300 certified by manufacturer) is acceptable for overall fenestration area.**
- **SHGC from Table A8.1 for unlabeled skylights.**
- **SHGC from Table A8.2 for other unlabeled vertical fenestration.**

Notes:

NFRC (National Fenestration Rating Council) test procedures:

100: U-Factors

200: Solar Heat Gain Coefficients (SHGC)

300: Solar Optical properties, incl. SC (Shading Coefficient)

400: Air leakage rates

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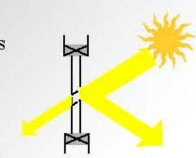
Fenestration SHGC Limits
(Section 5.5.4.4)

- SHGC of vertical fenestration and skylights to be ≤ maximum SHGC values in Table 5.5-z for "all" orientations.
- Exceptions:
  - **For overhangs, the SHGC is reduced by multiplier in Table 5.5.4.4.1**
  - **On street side, street level, if story ht. ≤20', and overhang >0.5PF, and WWR<0.75**



Observation:

There are no SHGC requirements for ***semiheated spaces in any*** climate zone nor for residential buildings in ***climate zones 7 and 8***.

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Overhangs

- Credit is given for permanent overhangs by adjustment to SHGC (Table 5.5.4.4.1)
- Size of credit is determined by projection factor

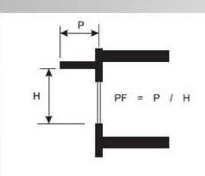

Figure 5-L—Overhang Projection Factor

TABLE 5.5.4.4.1
SHGC Multipliers for Permanent Projections

Projection Factor	SHGC Multiplier (All Orientations)	SHGC Multiplier (North-Oriented)
0 - 0.10	1.00	1.00
<0.10 - 0.20	0.91	0.95
<0.20 - 0.30	0.82	0.91
<0.30 - 0.40	0.74	0.87
<0.40 - 0.50	0.67	0.84
<0.50 - 0.60	0.61	0.81
<0.60 - 0.70	0.56	0.78
<0.70 - 0.80	0.51	0.76
<0.80 - 0.90	0.47	0.75
<0.90 - 1.00	0.44	0.73

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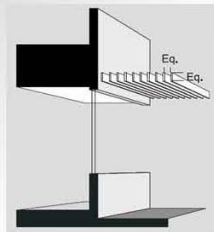
Overhangs

- Open slotted sun shades will also qualify if the sun is blocked out totally on June 21.

A couple useful formulae:

- Sun altitude angle on June 21 = 90 – Latitude + 23.5
- Sun altitude angle on Dec 21 = 90 – Latitude – 23.5



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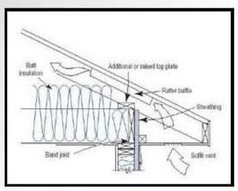
Insulation Installation (Section 5.8.1)

- Per manufacturer's instructions
- Achieve rated R-value
- No open-blown or poured loose-fill insulation when ceiling slope is > 3/12
- If eave vents installed
  - Provide baffling of air vents to deflect incoming air above the surface of the insulation
- Exception
  - Metal buildings – if roof and wall insulation is compressed between roof or wall skin and the structure



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Normative Appendix A

- Includes pre-calculated U-factors, C-factors and F-factors for
  - Above-grade walls
  - Below-grade walls
  - Floors
  - Slab-on-grade floors
  - Opaque doors
  - Fenestration

 57

Envelope Trade-off Option (Section 5.6)

- Building complies if:
  - It satisfies the provisions of 5.1, 5.4, 5.7 and 5.8, and
  - Envelope performance factor (EPF) of proposed building is ≤ EPF of budget building.
    - EPF considers only the building envelope components and is calculated using procedures in Normative Appendix C (ENVSTD software).
    - Schedules of operation, lighting power, equipment power, occupant density, and mechanical systems to be the same for both the proposed building and the budget building.

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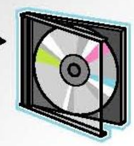
Normative Appendix C

- Specifies the trade-off methodology to be followed.
- ENVSTD →
  - A windows-based computer program for applying Appendix C
  - Covers all building envelope components
  - Drop down menus
  - Output demonstrates compliance



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ENVSTD Description (in Appendix C)

- ENVSTD performs an "energy performance factor" trade-off based on a series of regressions of building load simulations by envelope component.
- ENVSTD is not a simulation approach nor should the EPF be used as an indication of anything other than envelope compliance.

 60

15-min. Normative Break

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Part IV.

Part IV: Details of the HVAC and service water heating (SWH) provisions

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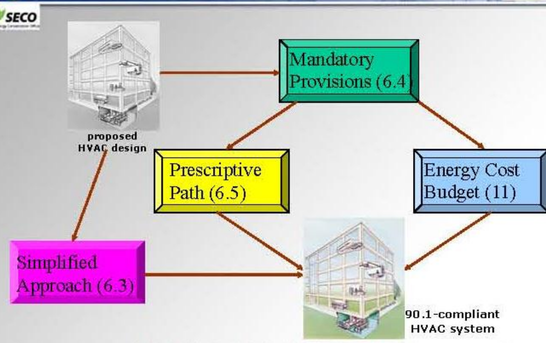
Section 6 – HVAC Compliance



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Simplified Approach Option for HVAC Systems (Section 6.3)

Simplified Approach

Limited to…

Buildings with 1 or 2 stories and with < 25,000ft², and that meet 15 criteria:

- Single-zone systems.
- Air-cooled or evaporatively-cooled unitary/split per Tables 6.8.1A, B, D.
- Economizer required per Table 6.5.1
  - But, no economizer required if system meets or exceeds conditions in Table 6.3.2
- Heating required per Tables 6.8.1B, D, E, F.
- OA ≤ 3000 cfm and < 70% of SA at minimum OA design, unless ERV.

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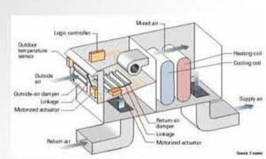
Simplified Approach for HVAC (cont.)

- Manual changeover or dual set-point thermostat.
- Controls on supplemental heaters on heat pumps.
- Prevent reheat or simultaneous heating and cooling for humidity control.
- Time clocks (except hotel/motel…); details in 6.3.2, part i.
- Pipe insulated per Table 6.8.3.
- Ductwork and plenums insulated per Tables 6.8.2A & 6.8.2B.
- Ducted system to be air balanced to industry standards.
- Interlocked t-stats to prevent simultaneous heating and cooling.
- Exhaust systems > 300 cfm that do *not* operate continuously have automatic dampers that close when not in use.
- Optimum start controls (design supply air capacity > 10,000 cfm).

 65

Economizers (Table 6.5.1)

Climate zone	Cooling capacity for which an economizer is required
1a, 1b, 2a, 3a, 4a (Houston, Miami, St. Louis, Wash. DC)	Economizer unnecessary
2b, 5a, 6a, 7, 8 (Del Rio, Yuma, Chicago, Edmonton)	≥ 135,000 Btu/h
3b, 3c, 4b, 4c, 5b, 5c, 6b (Dallas, El Paso, Denver, Seattle)	≥ 65,000 Btu/h



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Cooling EER Req'd to Eliminate Economizer (Table 6.3.2)

SECO

System size (kBtu/h)	Mandatory minimum EER	Climate Zones 5 to 8	4	3	2
Unitary systems w/ heat pump heating					
		Minimum cooling efficiency required (EER)			
≥65 and <135	10.1	N/A *	12.1	11.6	11.1
≥135 and < 240	9.3	N/A *	11.3	10.8	10.4
≥ 240 and <760	9.0	N/A *	10.9	10.5	10.0
* N/A means "No exemption Allowed."					
Other Unitary Systems					
		Minimum cooling efficiency required (EER)			
≥ 65 and < 135	10.3	N/A *	12.5	12.0	11.5
≥ 135 and < 240	9.7	N/A *	11.5	11.1	10.6
≥ 240 and < 760	9.5	N/A *	11.2	10.7	10.3

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Economizer Requirement (Consolidated Tables 6.3.2 and 6.5.1)

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Economizer requirements based on climate zone and system size

(Simple and Complex Systems)

System Size kBtu/h	Min. Eff. EER	Climate Zone 1 2a 3a 4a	2b	3bc	4bc	5a	5bc	6a	6b	7,8
			Min. EER for exemption in simple systems only							
<65	13.0	**	**	**	**	**	**	**	**	**
65-135	10.8 HP 11.0 O	**	**	11.6 HP 12.0 O	12.1 HP 12.5 O	**	RQ	**	RQ	**
135-240	10.4 HP 10.8 O	**	10.4 HP 10.6 O	10.8 HP 11.1 O	11.3 HP 11.5 O	RQ	RQ	RQ	RQ	RQ
>240	9.3 HP 9.8 O	**	10.0 HP 10.3 O	10.5 HP 10.7 O	10.9 HP 11.2 O	RQ	RQ	RQ	RQ	RQ

** No economizer required in any system. All other cells, economizer required in complex systems.

RQ = Economizer required in simple and complex systems

HP = EER value for exempting unitary "Heat Pumps" | O = EER value for exempting "Other" unitary systems

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Mech. Equipment Efficiency Standard Conditions (Section 6.4.1.1)

SECO

- Table 6.8.1A – Air conditioners and condensing units
- Table 6.8.1B – Heat pumps
- Table 6.8.1C – Standard water chillers
- Table 6.8.1D – PTAC and PTHP
- Table 6.8.1E – Furnaces, duct furnaces, and unit heaters
- Table 6.8.1F – Boilers
- Table 6.8.1G – Heat rejection equipment
- All furnaces with input ratings ≥ 225,000 Btu/h, including electric furnaces, that are not located in the conditioned space shall have have jacket losses ≤ 0.75% of the input rating"

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Mech. Equipment Efficiency Standard Conditions (Section 6.4.1.1)

SECO

Table 6.8.1A (partial)
Air Conditioners and Condensing Units –Efficiency Requirements

Equipment type	Size category	Heating section type	Sub-category or rating condition	Minimum efficiency
Air conditioner, air cooled	≥ 65,000 Btu/h & <135,000 Btu/h	Elec. Resistance (or none)	Split system & single package	EER 10.3 11.2 as of 1/1/2010 *
		All others	Split system & single package	EER 10.1 11.0 as of 1/1/2010 *
	<65,000 Btu/h	All	Split System	SEER 13 since 1/23/2006 *
			Single Package	SEER 13 since 1/23/2006 *
Through-the-wall, air cooled	<30,000 Btu/h	All	Split System	SEER 10.9 12 as of 1/23/2010 *
			Single Package	SEER 10.6 12 as of 1/23/2010 *

* Dates that Federal regulations become/became mandatory.

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Mech. Equipment Efficiency Standard Conditions (Section 6.4.1.1)

SECO

Table 6.8.1B (partial) - Electrically Op. Unitary and Heat Pumps – Efficiency Req'mts

Equip. Type (air-cooled, cooling mode)	Size Category (Btu/h)	Htg Section Type	Sub-category or Rating condition	Minimum Eff. Since 1/23/2006	Minimum Eff. As of 1/1/2010 (IPLV)
Air-cooled (package and split)	65,000	All	Split system	SEER 13	
			Single package	SEER 13	
	65-135,000	Elec. resist.	Split & single	EER 10.1	EER 11
		All other	Split & single	EER 9.9	EER 10.8
	135-240,000	Elec. resist.	Split & single	EER 9.3	EER 10.6
		All other	Split & single	EER 9.1	EER 10.4
	240,000	Elec. resist.	Split & single	EER 9.0	EER 9.5 (9.2)
		All other	Split & single	EER 8.8	EER 9.3 (9.0)
Thru-wall	30,000	All	Split system	SEER 10.9	SEER 12 *
			Single package	SEER 10.6	SEER 12 *
Small duct high velocity	65,000	All	Split system	SEER 10	

* These requirements take effect on 1/23/2010

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Water Chilling Packages

SECO

Table 6.8.1C (partial)
Water Chilling Packages – Minimum Efficiency Requirements

Equipment Type	Size Category	Subcat	Minimum Efficiency
Air Cooled, with Condenser, Electrically Operated	All sizes	n.a.	2.80 COP, 3.05 IPLV
Air Cooled without condenser	All sizes	n.a.	3.10 COP, 3.45 IPLV
Air cooled, elec. Operated, positive displacement, recip.	All sizes	n.a.	4.20 COP, 5.05 IPLV
Water cooled, elec. Operated, positive displacement, rotary	<150 tons	n.a.	4.20 COP, 5.05 IPLV
	150-300 tons	n.a.	4.20 COP, 5.05 IPLV
	>300 tons	n.a.	4.20 COP, 5.05 IPLV
Water cooled, elec. Operated, positive displacement, rotary	<150 tons	n.a.	4.20 COP, 5.05 IPLV
	150-300 tons	n.a.	4.20 COP, 5.05 IPLV
	>300 tons	n.a.	4.20 COP, 5.05 IPLV

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Packaged A.C. & Heat Pumps

Table 6.8.1D (partial)
Packaged terminal air conditioners, heat pumps, vertical air conditioners, room a.c. – Minimum Efficiency Requirements

Equipment type *	Size category (input)	Subcategory or rating condition	Minimum efficiency
SPVAC (clg mode) *	All capacities	95Fdb/75Fwb	EER 8.6
SPVHP (clg mode) *	All capacities	95Fdb/75Fwb	EER 8.6
SPVHP (htg mode) *	All capacities	47Fdb/43Fwb	COP 2.7
Room a.c. w/ louvered sides *	<6000 Btu/h		SEER 9.7
	6000-8000 Btu/h		EER 9.7

* These were added in the 90.1-2004 version.

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Warm Air Furnaces & Unit Heaters

Table 6.8.1E (partial)
Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces and Unit Heaters

Equipment Type	Size Category (Input)	Sub-category or Rating Condition	Minimum Efficiency
Warm Air Furnace, Gas-fired	< 225,000 Btu/h		78% AFUE or 80% E_t
	≥ 225,000 Btu/h	Maximum Capacity	80% E_c

Notes: E_t = thermal efficiency
E_c = combustion efficiency (100% - flue losses)

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Centrifugal Chillers < 150 Tons
(Table 6.8.1H, Partial)

Table 6.8.1H Minimum Efficiencies for Centrifugal Chillers < 150 tons

Centrifugal Chillers < 150 tons, COP_{std} = 5.00; $IPLV_{std}$ = 5.25

			Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
Lv chilled water temp (F)	Ent. Cond. Water temp (F)	Lift (F)	COP NPLV	COP NPLV	COP NPLV	COP NPLV	COP NPLV	COP NPLV
40	75	35	5.11 5.35	5.33 5.58	5.48 5.73	5.67 5.93	5.79 6.06	5.88 6.15
42	80	38	4.84 5.06	5.10 5.33	5.25 5.49	5.43 5.67	5.53 5.79	5.61 5.87
44	85	41	4.49 4.69	4.82 5.04	5.00 5.25	5.20 5.43	5.30 5.55	5.38 5.62
46	75	29	5.58 5.84	5.83 6.10	6.03 6.30	6.32 6.61	6.54 6.84	6.70 7.00
48	85	37	4.94 5.16	5.18 5.42	5.32 5.57	5.50 5.76	5.62 5.87	5.70 5.96

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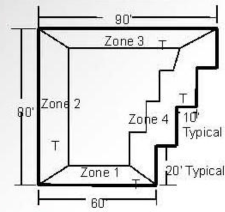
HVAC Controls
(Section 6.4.3)

- Zone Thermostatic controls *(Section 6.4.3.1)*
  - Required for each zone
  - Dead Band controls
  - Set Point Overlap Restrictions
- Off-Hour controls *(Section 6.4.3.2)*
  - Automatic Shutdown
  - Setback Controls
  - Optimum Start Controls
  - Zone Isolation



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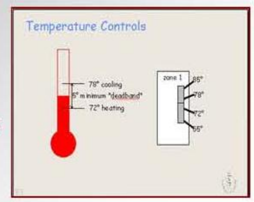
Thermostat Dead Band
(Section 6.4.3.1.2)

- Thermostats must have a dead band of at least 5° F.
- Exceptions
  - "Thermostats that require manual changeover between heating and cooling modes.
  - Special occupancy or applications where wide temperature ranges aren't acceptable" (e.g., retirement homes) and approved by adopting authority.



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Off-hour Controls
(Section 6.4.3.3)

- HVAC systems shall have the following off-hour controls:
  - automatic shutdown
  - setback controls
  - optimum start controls
  - zone isolation

- Exceptions, HVAC systems
  - intended to operate continuously, or
  - having <15,000 Btu/h htg & clg capacity w/ manual on-off controls. *

* Was ≤65,000 Btu/h and ¾ h.p. system fan power in 2001 edition.

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Automatic Shutdown
(Section 6.4.3.3.1)

SECO

- **Controls to operate on different time schedules for seven different day-types per week (residential may have just two schedules) and retain programming and time setting during loss of power for at least 10 hrs, or**
- **An occupant sensor, or**
- **A manually-operated timer with maximum two hour duration, or**
- **An interlock to security system**

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Setback Controls
(Section 6.4.3.3.2)

SECO

- **Applies to heating systems located in all climates except zone 1, with heating set point adjustable to ≤ 55° F.**
- **Applies to cooling systems in climate zones 1b, 2b, & 3b, with set point adjustable to at least 90F, or to prevent high space humidity levels.**
- **Exception**
  - **"Radiant floor and ceiling heating systems"**

✓ *Note: There is no climate zone "1b" in the U.S.*

 80

Optimum Start Controls
(Section 6.4.3.3.3)

SECO

- **Individual heating and cooling air distribution systems with total design supply air capacity > 10,000 cfm.**
- **Control algorithm to at least "be a function of difference between space temperature and occupied setpoint and amount of time prior to scheduled occupancy."**

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Gravity Hoods, Vents, & Ventilators (Section 6.4.3.4.2)

SECO

- **"All o.a. supply & exhaust hoods, vents and ventilators shall be equipped with motorized dampers that will automatically shut when the spaces served are not in use"**
- **Exceptions**

a. **Gravity dampers o.k. in bldgs:**
- < 3 stories in height above grade.
- All bldgs in climate zones 1, 2, and 3.

b. Ventilation systems serving unconditioned spaces.

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Dampers
(Section 6.4.3.4.4)

SECO

"Where o.a. supply and exhaust dampers are required, they shall have a maximum leakage rate (per AMCA Standard 500) as shown in this table."

Table 6.4.3.4.4)

Climate zones	Maximum damper leakage at 1" w.g. (cfm per sq.ft. of damper area)	
	Motorized	Non-motorized
1, 2, 6, 7, 8	4	Not allowed if damper is required
All others (3, 4, 5)	10	20 *

* Dampers < 24" in any dimension may have leakage of 40 cfm/sq.ft.

 83

Ventilation Fan Controls
(Section 6.4.3.4.5)

SECO

- Fans with motors > ¾ h.p. (0.5 kW) shall have automatic controls complying with section 6.4.3.3.1 that are capable of shutting off fans when not required *.

* **Section 6.4.3.3.1 (automatic shutdown of HVAC systems) stipulates either: time schedule controls, occupant sensors, adjustable timer, or interlock to a security system that shuts system off when security system is activated.**

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Ventilation Control for High Occ.
(New Section 6.4.3.9)

Demand control ventilation (DCV) required for spaces > 500 ft² and > 40 people / 1000 ft² that are served by any of these:

- Air-side economizer
- Auto modulation of o.a. damper
- Design air flow > 3000 cfm

- Exceptions:
  - Energy recovery system per section 6.5.6.1.
  - Multiple-zone systems w/o DDC
  - O.A. < 1200 cfm
  - Where supply air – makeup < 1200 cfm.

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Duct & Plenum Insulation
(Section 6.4.4.1.2)

- All supply and return ducts and plenums to be insulated per Tables 6.8.2A and 6.8.2B
- Four exceptions (on next slide)

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Duct Insulation Exceptions

(a) "Factory-installed plenums, casings, or ductwork furnished as part of HVAC equipment

(b) Ducts or plenums located in heated, semi-heated, or cooled spaces

(c) For runouts < 10 ft in length to air terminals or air outlets, the R-value need not exceed R-3.5

(d) Backs of air outlets and outlet plenums exposed to unconditioned or indirectly conditioned spaces with face areas > 5 ft² need not exceed R-2; those ≤ 5 ft² need not be insulated"

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Min. Duct Insulation R-value
(Table 6.8.2B)

(For heating and cooling combo ducts)

Climate Zone	Duct Location						
	Exterior	Ventilated attic	Unvented attic above insul. clg.	Unvented attic w/ roof insulation	Un-conditioned space	Indirectly conditioned space	Buried
Supply ducts							
1	R-6	R-6	R-8	R-3.5	R-3.5	none	R-3.5
2	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
3	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
4	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
5	R-6	R-6	R-6	R-1.9	R-3.5	none	R-3.5
6	R-8	R-6	R-6	R-1.9	R-3.5	none	R-3.5
7	R-8	R-6	R-6	R-1.9	R-3.5	none	R-3.5
8	R-8	R-8	R-8	R-1.9	R-6	none	R-6
Return ducts *							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none

* Added in the 90.1-2004 version

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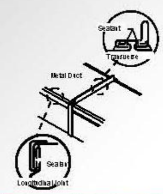
Duct Sealing
(Section 6.4.4.2.1)

- Table 6.4.4.2A
  - Seal level based on duct type (supply, exhaust, return) and duct location (outdoors, unconditioned spaces, conditioned spaces)
- Table 6.4.4.2B
  - lists sealing requirements based on seal level from Table 6.4.4.2A
- Requirements of 6.4.4.2.2 (leakage tests)
- Standard industry practice



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Minimum Duct Seal Level
(Table 6.4.4.2A)

Duct Location	Duct Type			
	Supply		Exhaust	Return
	≤2 in. w.c.	>2 in. w.c.		
Outdoors	A	A	C	A
Unconditioned Spaces	B	A	C	B
Conditioned Spaces	C	B	B	C

Table 6.4.4.2B Duct Seal Levels

Seal Level	Sealing Requirement
A	All transverse joints, longitudinal seams, and duct wall penetrations. *
B	All transverse joints and longitudinal seams. *
C	Transverse joints only.

* Unless certified in compliance with UL-181A or UL-181B by independent test lab.

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Duct Leakage Tests
(Section 6.4.4.2.2)

- For ductwork designed > 3 in. w.c.
  - Leak tested
  - Representative sections > 25% of the total installed duct area shall be tested
  - Ratings > 3 in. w.c. to be identified on drawings
  - Maximum permitted duct leakage shall be calculated and specified.

 91

Permitted Duct Leakage
(Section 6.4.4.2.2)

The maximum permitted duct leakage shall be:

$$L_{\max} = C_L P^{0.65}$$

where,

$L_{\max}$ = maximum permitted leakage in cfm/100 ft² duct surface area"

C_L = leakage class, cfm/100 sq.ft. @ 1" w.c.
= 6 for rectangular duct
= 3 for round duct

P = Test (design) pressure, in " w.c.

 92

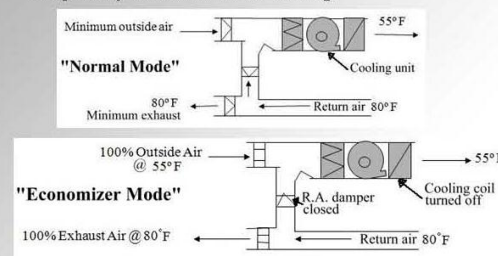
Piping Insulation
(Section 6.4.4.1.3)

- Must meet requirements in Table 6.8.3
  - Minimum pipe insulation thickness based on fluid design operating temperature range, insulation conductivity, nominal pipe or tube size, and system type (Heating, SWH, Cooling)
- Exceptions
  - Factory-installed
  - Piping conveying fluids between 60°F and 105°F
  - Piping conveying fluids not heated or cooled with purchased energy.
  - "Hot water piping between shut off valve and coil, ≤ 4 ft in length, when located in conditioned spaces
  - Pipe unions in heating systems (steam, steam condensate, and hot water)"

 93

Economizer - Design Capacity
(Section 6.5.1.1.1)

"System capable of modulating outside air and return air dampers to provide up to 100% of the design supply air quantity as outside air for cooling"



 94

High Limit Shutoff
(Section 6.5.1.1.3)

- Automatically reduce *outdoor air* intake to the design minimum *outdoor air* quantity when outside air intake will no longer reduce cooling energy usage"
- High-limit shutoff control types for specific climates from Table 6.5.1.1.3A
- High-limit settings from Table 6.5.1.1.3B

 95

Air Economizer Controls
High-limit Shutoff Settings

Table 6.5.1.1.3A

Climate zones	Allowed control types	Prohibited control types
1b, 2b, 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8	Fixed dry bulb (DB) Differential dry bulb Electronic enthalpy Differential enthalpy DP and DB temperature	Fixed enthalpy
1a, 2a, 3a, 4a	Fixed dry bulb (DB) Fixed enthalpy Electronic enthalpy Differential enthalpy DP and DB temperature	Differential dry bulb
All other climates	Fixed dry bulb (DB) Differential dry bulb Fixed enthalpy Electronic enthalpy Differential enthalpy DP and DB temperature	

* DP= Dew Point Temperature; DB= Dry Bulb Temperature

 96

Air Economizer Controls
High-limit Shutoff Settings (Table 6.5.1.1.3B)

Device type	Climate	Required high limit (economizer off when..)	
		Equation	Description
Fixed DB	1b,2b,3b,3c,4b,4c, 5b,5c,6b,7,8	T_{oa} > 75F	o.a. temp. exceeds 75F
	5a,6a,7a	T_{oa} > 70F	o.a. temp. exceeds 70F
	All other zones	T_{oa} > 65F	o.a. temp. exceeds 65F
Differential DB	1b,2b,3b,3c,4b,4c, 5b,5c,6a,6b,7,8	T_{oa} > T_{RA}	o.a. temp exceeds ret. air temp
Fixed enthalpy	All	H_{oa} > 28 Btu	o.a. enthalpy exceeds 28 Btu/lb.
Electronic enthalpy	All	(T_{oa}, RH_{oa}) >A	o.a. temp/RH exceeds the "A" set point curve.
Differential enthalpy	All	H_{oa} > H_{RA}	Outdoor enthalpy exceeds return air enthalpy
DP and DB temp.	All	DP_{oa} > 55F, or T_{oa} > 75F	Outdoor DP exceeds 55F (65 gr/lb.) or outdoor DB > 75F

* DP and DB control settings were added for 90.1-2004

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Economizer Damper Leakage
(Section 6.5.1.1.4)

- Return air and outdoor air dampers shall meet the damper leakage specified in 6.4.3.3.4.
- **This avoids cross-over leakage through the R.A. damper when in 100% o.a. economizer mode.**

Table 6.4.3.3.4		
Climate or Climate zones	Maximum damper leakage at 1" w.g. (cfm per sq.ft. of damper area)	
	Motorized	Non-motorized
1, 2, 6, 7, 8	4	Not allowed
All others	10	20 *

* Dampers < 24" in any dimension may have leakage of 40 cfm/sq.ft.

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Simultaneous Htg & Clg Limitations (Section 6.5.2)

- **Zone controls capable of operating in sequence the supply of heating and cooling energy to the zone to prevent:**
  - reheating,
  - recooling,
  - mixing, or
  - simultaneously supplying air previously heated or cooled
- **Hydronic system controls to prevent reheating or re-cooling of fluids.**

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Zone Controls - Exceptions

- **"Zones for which volume of air that is reheated, recooled, or mixed is no greater than the larger of the following:**
  - Volume of outside air to meet Section 6.2 of ASHRAE 62.1 for the zone.
  - 0.4 cfm/ft^2 of zone conditioned floor area.
  - 30% of zone design peak supply.
  - 300 cfm for zones whose peak flow rate totals no more than 10% of the total fan system flow rate.
  - Any higher rate that can be demonstrated to jurisdiction to reduce overall system annual energy usage…
- **Zones where special pressurization relationships, cross-contamination requirements, or code-required minimum circulation rates are such that the variable air volume systems are impractical.**
- **Zones where at least 75% of the energy for reheating or for providing warm air in mixing systems is provided from a *site-recovered* or *site-solar energy source*."**

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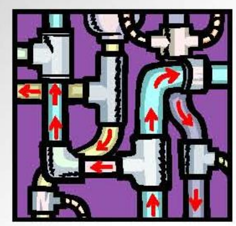
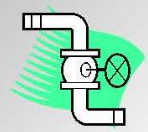
Three-pipe System
(Section 6.5.2.2.1)

- **That's a NO-NO!**
- **No common return system for both hot and chilled water.**





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Two-pipe Changeover System
(Section 6.5.2.2.2)

- **Common distribution system acceptable if:**
  - **deadband from one mode to another is ≥ 15° F outside air temperature.**
  - **controls to allow operation of ≥ 4 hours before changing over.**
  - **reset controls that allow heating and cooling supply temperatures at changeover point to be ≤ 30° F apart.**

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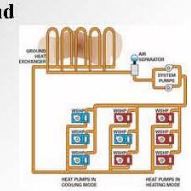
Hydronic (water loop) Heat Pump Systems (Section 6.5.2.2.3)

- Controls to provide “heat pump water supply temperature deadband of at least 20° F between initiation of heat rejection and heat addition by central devices.”
- In climate zones 3-8, cooling tower bypass or cooling tower isolation dampers.
- Exception
  - If system loop temperature optimization controller is used, deadband < 20° F is allowed.



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Fan Power Limitation (Options 1&2, Section 6.5.3.1.1)

(This is a totally new method with 90.1-2007)

Table 6.5.3.1.1A Fan Power Limitation #

Option	Limit	Constant Volume	Variable Volume
1	Allowable Nameplate hp	hp≤1.1 hp/1000 cfm	hp≤1.5 hp/1000 cfm
2	Allowable Fan system bhp	bhp≤0.94 hp/1000 cfm + A *	bhp≤1.3 hp/1000 cfm + A *

* Compute $A = \sum (PD_i \times CFM_i / 4131)$, where:
PD_i = pressure drop (in. wc) adjustment for each “i” component in Table 6.5.3.1B (next slide), and
CFM_i = CFM through component “i”

\# Compute “installed bhp” $= \sum [PD_j \times CFM_j / (6356 \times \eta_j)]$, where:
PD_j = pressure drop (in. wc) across fan system “j”
CFM_j = CFM of fan system “j”
η_j = efficiency of fan system “j” (assumed to be 0.65 allowable limits)

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Fan Power Limitation (Option 2 - Section 6.5.3.1.1)

This is Table 6.5.3.1.1B for the brake horsepower (bhp) option 2.

Table 6-F—Fan Power Limitation Pressure Drop Adjustments (Table 6.5.3.1.1.B)

Device	Adjustment
Credits	
Fully ducted return and/or exhaust air systems	0.5 in. w.c.
Return and/or exhaust airflow control devices	0.5 in. w.c
Exhaust filters, scrubbers, or other exhaust treatment	The pressure drop of device calculated at fan system design condition.
Particulate Filtration Credit: MERV 9 through 12	0.5 in. w.c.
Particulate Filtration Credit: MERV 13 through 15	0.9 in. w.c.
Particulate Filtration Credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2× clean filter pressure drop at fan system design condition
Carbon and other gas-phase air cleaners	Clean filter pressure drop at fan system design condition
Heat recovery device	Pressure drop of device at fan system design condition
Evaporative humidifier/cooler in series with another cooling coil	Pressure drop of device at fan system design condition
Sound Attenuation Section	0.15 in. w.c.
Deductions	
Fume Hood Exhaust Exception (required if 6.5.3.1.1 Exception (c) is taken)	-1.0 in. w.c.

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Part-load Fan Power Limitation (Section 6.5.3.2.1)

- Individual VAV fans with motors ≥ 10 hp *
  - Shall have VSD, or
  - Shall be vane-axial w/ variable pitch blades, or
  - Shall have other controls and devices to result in fan motor demand ≤ 30% of design wattage at 50% of design air volume when static pressure set point = 1/3 of total design static pressure, based on *manufacturer's* certified fan data.

* Was 30 hp in 90.1-2001 and 15 hp in 90.1-2004.

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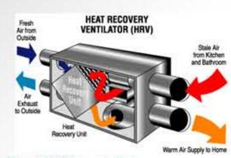
Exhaust Air Energy Recovery (Section 6.5.6.1)

- Incorporate exhaust air energy recovery in systems with
  - ≥ 70% outside air and ≥ 5000 cfm total
  - At least 50% energy recovery effectiveness
- Nine exceptions …

(on page 41)



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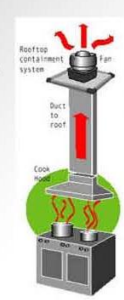
Exceptions to Exhaust Heat Recovery

(a) Laboratory fume hoods systems meeting Section 6.5.7.2 (applying to Fume Hoods>15,000 cfm)
(b) Systems serving uncooled spaces and are heated to < 60° F.
(c) Systems exhausting toxic, flammable, paint or corrosive fumes or dust.
(d) Commercial kitchen hoods used for collecting and removing grease vapors and smoke.
(e) Where > 60% of *outdoor air* heating energy is provided from site-recovered or site-solar energy.
(f) Heating systems in climate zones 1 through 3.
(g) Cooling systems in climate zones 3c, 4c, 5b, 5c, 6b, 7, & 8.
(h) Where largest exhaust source is < 75% of the design *outdoor air* flow.
(i) Systems requiring dehumidification that employ energy recovery in series with the cooling coil.



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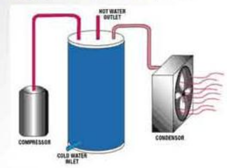
Heat Recovery for SWH
(Section 6.5.6.2)

- **Condenser recovery required for service water heating if:**
  - **Used 24 hrs per day and**
  - **Heat rejection > 6,000,000 Btu/h (approx. 375 tons) and**
  - **SWH load > 1,000,000 Btu/h**



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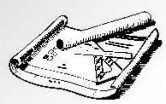
Completion Requirements
(Section 6.7.2)



- Record drawings
- Operating and maintenance manuals
- System balancing
- System commissioning

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Record Drawings
(Section 6.7.2.1)

Record drawings of actual installation to building owner within 90 days of system acceptance and include, as a minimum:

- "Location and performance data on each piece of equipment
- General configuration of duct and pipe distribution system including sizes
- Terminal air or water design flow rates"

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Manuals
(Section 6.7.2.2)

Operating and maintenance manuals to building owner within 90 days of system acceptance and include, as a <u>minimum:</u>

- Equipment size and selected options
- Operation manuals for each piece of equipment requiring maintenance with actions clearly identified.
- Names & address of at least one service agency.
- HVAC Control system maintenance information.
- A complete narrative of how each system is intended to operate.

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System Balancing
(Section 6.7.2.3)

- **HVAC systems balanced in accordance with standards in Appendix E.**
- **Written report for conditioned spaces > 5000 ft^2.**

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Air System Balancing
(Section 6.7.2.3.2)

- **Minimize throttling losses**
- **For fans with system power > 1 hp shall be adjusted to meet design flow conditions.**

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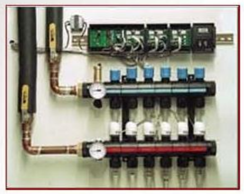
Hydronic System Balancing
(Section 6.7.2.3.3)

- Proportionately balanced to minimize throttling losses.
- Pump impeller trimmed or pump speed adjusted to meet design flow conditions.
- Exceptions



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Exceptions

- "Pumps with pump motors ≤ 10 hp
- When throttling results in ≤ 5% of the nameplate hp draw, or 3 hp, whichever is greater, above that required if the impeller was trimmed."

 116

System Commissioning
(Section 6.7.2.4)

- "Ensure that control elements are calibrated, adjusted, and in proper working condition."
- In plans and specs, provide detailed instructions for commissioning of projects > 50,000 ft² of conditioned area.
  - Except warehouses and semiheated spaces.

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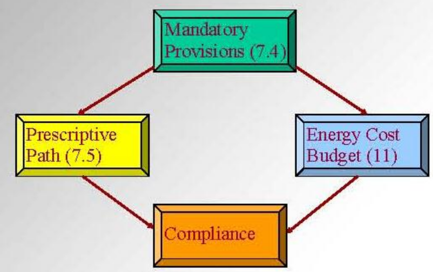
Service Water Heating Compliance (Section 7)



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Section 7 - Service Water Heating

- General *(Section 7.1)*
- Compliance Path(s) *(Section 7.2)*
- Mandatory Provisions *(Section 7.4)*
  - Load calculations
  - Equipment efficiency
  - Service hot water piping insulation
  - System controls
  - Pools
  - Heat traps
- Prescriptive Path *(Section 7.5)*
  - Space heating and water heating
  - Service water heating equipment
- Submittals *(Section 7.7)*

 119

SWH Equipment Efficiency
(Section 7.4.2)

- Minimum efficiencies are shown in Table 7.8
- Equipment not listed in Table 7.8 has no minimum performance requirements.
- Exception: Water heaters and hot water supply boilers > 140 gal storage capacity don't have to meet ***standby loss*** (SL) requirements when
  - tank surface is thermally insulated to R-12.5, **and**
  - a standing pilot light isn't installed, **and**
  - gas- or oil-fired water heaters have a flue damper or fan-assisted combustion."

 120

Water Heating Equipment
Performance Requirements (Table 7.8)

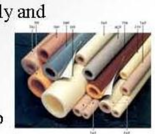
This is a partial segment of Table 7.8

Equipment Type	Size Category	Sub-category or Rating Condition	Performance Required, (EF=Efficiency Factor SL=Standby Losses)
Gas Storage Water Heaters	≤ 75,000 Btu/h	≥ 20 gallons	0.62-0.0019V (EF)
	> 75,000 Btu/h	< 4000 (Btu/hr)/gal.	min. 80% E_t & max. [Q/800 + 110 $\sqrt{V}$] (SL), Btu/h
Hot Water Supply Boilers, Gas		≥ 4000 (Btu/hr)/ gal. and ≥ 10 gal.	min. 80% E_t & max. [Q/800 + 110 $\sqrt{V}$] (SL), Btu/h
Hot Water Supply Boilers, Oil		≥ 4000 (Btu/hr)/ gal. and ≥ 10 gal.	min. 78% E_t & max. [Q/800 + 110 $\sqrt{V}$] (SL), Btu/h
Heat pump pool heater	All		4.0 COP

 121

Service H.W. Piping Insulation
(Section 7.4.3)

- The following shall comply with Table 6.8.3 in the HVAC Section 6:
- Circulating tank type system
  - ➢ Recirculating system piping, including supply and return piping
- Nonrecirculating storage system
  - ➢ First 8 ft of outlet piping
  - ➢ Inlet pipe between storage tank and heat trap
- Externally-heated pipes (heat trace or impedance heating)



 122

Circulating Pump Controls
(Section 7.4.4.4)

To limit operation to "a period from the start of the heating cycle to a maximum of five minutes after the end of the heating cycle"

 123

Pools (Section 7.4.5)

- Pool heaters to have readily accessible on-off switch.
- Pool heaters fired by natural gas - NO continuously burning pilot lights.
- Vapor retardant pool covers required (unless 60% heat is recovered or solar heat). Pools kept >90F require R-12 insul. cover.
- Time switches required.

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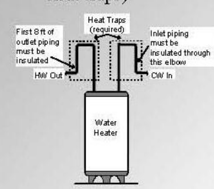
Heat Traps (Section 7.4.6)

Non-recirculating systems to have heat traps on both the inlet and outlet piping as close as practical to storage tank (if no integral heat traps)



Insulation level per Table 6.8.3

- Either a device specifically designed for this purpose or
- "Arrangement of tubing that forms a loop of 360° or piping that from the point of connection to the water heater includes a length of piping directed downward before connection to the vertical piping of the supply water or hot water distribution system, as applicable"

 125

Heat Traps (Section 7.4.6)

Other Heat Trap Options:

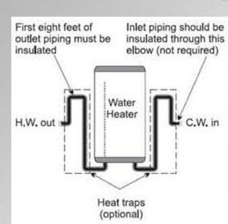


Figure 7-E—Heat Traps on a Tank with Connections on Bottom

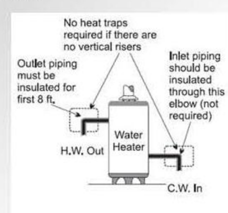


Figure 7-F—Heat Traps on a Tank with Connections on Sides

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Standby Loss Equation (Section 7.5.1)

- Standby loss not to exceed:

$$\frac{(13.3 \times pmd + 400)}{n}$$

where *pmd* is probable maximum demand in gal/h and *n* is the fraction of the year when outdoor daily mean temperature is > 64.9° F.

 127

Section 8 - Power

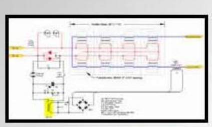
Mandatory Provisions

- Voltage drop
- Completion requirements

 128

Voltage Drop (Section 8.4.1)

- Two types of conductors
  - Feeder conductors
    - Run between the service entrance equipment and the branch circuit distribution equipment
    - 2% maximum voltage drop allowed
  - Branch circuit conductors
    - Run from the final circuit breaker to the outlet or load
    - 3% maximum voltage drop allowed



These requirements are more stringent than non-enforceable requirements in the National Electric Code (NEC.)

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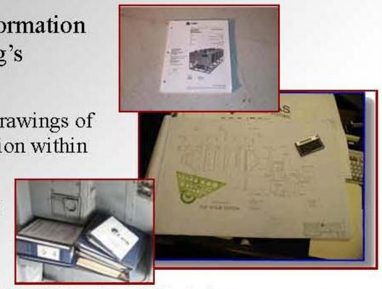
Submittals (Section 8.7)

Owner gets information about the building's electrical system

- 8.7.1 Record drawings of actual installation within 30 days.
- 8.7.2 Manuals



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Part V.

Part V: Details of the lighting, power and equipment provisions

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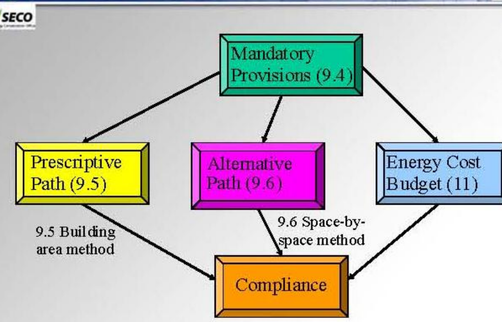
Section 9. Lighting Compliance



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Section 9 – Lighting Sections

- General Application *(Section 9.1)*
- Mandatory Provisions *(Section 9.4)*
  - ➢ Lighting controls
  - ➢ Tandem wiring
  - ➢ Exit signs
  - ➢ Installed interior lighting power
  - ➢ Luminaire wattage
  - ➢ Exterior building grounds lighting

- Building Area Compliance Path *(Section 9.5)*
- Space-by-Space Compliance Path (*Section 9.6*)

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Lighting UPD Comparisons
(from Table 9.5.1, 2007 same as 2004)

Building Type	2001 LPD	2004 LPD	% Reduction	Building Type	2001 LPD	2004 LPD	% Reduction
Automotive Facility	1.5	0.9	40%	Multi-Family	1.0	0.7	30%
Convention Center	1.4	1.2	14%	Museum	1.6	1.1	31%
Court House	1.4	1.2	14%	Office	1.3	1.0	23%
Dining: Bar Lounge/Leisure	1.5	1.3	13%	Parking Garage	0.3	0.3	0%
Dining: Cafeteria/Fast Food	1.8	1.4	22%	Penitentiary	1.2	1.0	17%
Dining: Family	1.9	1.6	16%	Performing Arts Theatre	1.5	1.6	-7%
Dormitory	1.5	1.0	33%	Police/Fire Station	1.3	1.0	23%
Exercise Center	1.4	1.0	29%	Post Office	1.6	1.1	31%
Gymnasium	1.7	1.1	35%	Religious Building	2.2	1.3	41%
Healthcare-Clinic	1.0	1.0	0%	Retail	1.9	1.5	21%
Hospital	1.6	1.2	25%	School/University	1.5	1.2	20%
Hotel	1.7	1.0	41%	Sports Arena	1.5	1.1	27%
Library	1.5	1.3	13%	Town Hall	1.4	1.1	21%
Manufacturing Facility	2.2	1.3	41%	Transportation	1.2	1.0	17%
Motel	2.0	1.0	50%	Warehouse	1.2	0.8	33%
Motion Picture Theatre	1.6	1.2	25%	Workshop	1.7	1.4	18%

Average reduction = 25%

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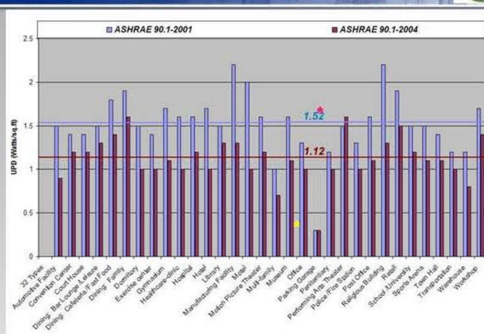
Lighting UPD Comparisons
(from Table 9.5.1, 2007 same as 2004)



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Lighting Power Allowance Exemptions

- Theatrical, stage, film, and video production
- Medical and dental procedures
- Exhibit displays for museums, monuments, and galleries
- Plant growth or maintenance
- Integral to equipment or instrumentation installed by manufacturer
- Integral to both open and glass-enclosed refrigerator and freezer cases
- Retail display windows, provided the display is enclosed by ceiling-height partitions
- Food warming and food preparation equipment
- Interior spaces specifically designated as registered interior historic landmarks
- Integral part of advertising or directional signage
- Exit signs
- Sale or lighting educational demonstration systems
- Lighting for television broadcasting in sporting activity areas
- Casino gaming areas
- Furniture-mounted supplemental task lighting controlled by automatic shutoff and complying with 9.4.1.4(d)
- For use in areas specifically designed for occupants with special needs

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Luminaire Wattage Determination *(Section 9.1.4)*

- Standard incandescent = maximum labeled wattage of the luminaire
- Luminaires with ballasts = wattage of the lamp/ballast combination
- Line-voltage track = minimum 30 W per foot or wattage of circuit breaker or other current-limiting device
- Low-voltage track = transformer wattage
- All others as specified

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Luminaire Wattage Calculations
(Section 9.1.4)

Example:
Calculate the total lighting Wattage of a room containing the following fixtures:

A. Eight 2'x 4' Fluorescent Fixtures
   Three 4' fluorescent T8 lamps per fixture, 32 Watts
   - 1 three-lamp electronic ballast
   - Ballast Input Wattage - 90 watts

B. 6 Incandescent Downlights
   - Specified Lamps - 60 Watt, A-line, Medium Screw Base
   - Maximum labeled wattage of fixture - 75 Watts

C. 16 Feet of Line Voltage Track
   - Specified - 5 Track Heads
   - 90 Watt Halogen PAR38 lamps

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Luminaire Wattage Calculations
(Section 9.1.4)

Solution: Total Lighting Wattage Calculation

Wrong Way!

- 8 Fixtures x 3 Lamps x 32 Watts per Lamp = 768 Watts
- 6 Downlights x 60 Watts/A-line lamp = 360 Watts
- 5 Track Heads x 90 Watts/Halogen Par Lamp = 450 Watts
- Total Wattage = 1578 Watts

Right Way!

- 8 Fixtures x 90 Ballast Input Watts = 720 Watts
- 6 Downlights x 75 Watt Labeled A-line Fixture = 450 Watts
- 16' Track x 30 Watts/Foot = 480 Watts
- Total Wattage = 1650 Watts

Exterior Lighting Control
(Section 9.4.1.3)

- Photocell w/ timer, or astronomical time switch required
- Seven-day electrically-driven, mechanical clocks with trippers, astronomical dial, and four-hour spring-wound storage
- Seven-day or calendar year, electronic programmable time switches with astronomic correction and battery backup
- Any of the timers above with a photocell (in place of astronomical correction)
- Exceptions – lighting for
  - Covered vehicle entrances
  - Exits from buildings or parking structures
  - (where required for safety, security, or eye adaptation.)

Automatic Lighting Shutoff
(Section 9.4.1.1)

Mandatory Provisions

- Applies to buildings > 5000 ft^2
  - Time-scheduling devices that accommodate separate schedules for each floor or each space > 25,000 ft^2, **or**
  - Occupant-sensing devices that turn off lights in each controlled space within 30 minutes of last occupant detection, **or**
  - Signal from another control or alarm system that indicates area is unoccupied.

Additional Control
(Section 9.4.1.4)

- Additional *separate* control required for:
  - Display/accent lighting
  - Case lighting
  - Task lighting
  - Hotel/motel guest room lighting
  - Nonvisual lighting (e.g., plants)
  - Demonstration lighting





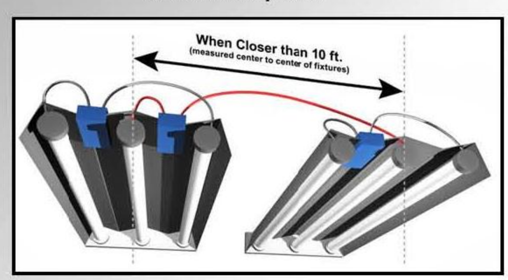
Space Lighting Control
(Section 9.4.1.2)

At least one independent control (occ. sensor, manual switch or other) must be in each room or space enclosed by ceiling-height partitions.

- Classrooms, conference rooms, and employee lunch rooms must have an occupancy sensor that turns lights off within 30 minutes of vacating (not applicable to shop, lab and K-12 classrooms.)
- Readily accessible, labeled & visible to occupants – can be remote (w/ pilot light) for reasons of safety or security.
- In spaces $\leq$ 10,000 ft^2, each control can serve a maximum of 2500 ft^2
- In spaces > 10,000 ft^2, each control can serve a maximum of 10,000 ft^2

Tandem Wiring Requirement
(Section 9.4.2)

When each lamp >30W



Tandem Wiring Exceptions
(Section 9.4.2)

- Separated surface or pendant luminaires
- Recessed luminaires more than 10 ft apart
- Other luminaires
  - With three-lamp ballasts
  - On emergency lighting circuits
  - With no available pair
  - With one lamp, high frequency, electronic ballast

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Exit Signs
(Section 9.4.3)

- Internally illuminated exit signs shall not exceed **5W** per face
- LED lamps okay
- Majority of incandescent lamps not okay

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Exterior Building Grounds Lighting (Section 9.4.4)

- Luminaires that operate at > 100 W require efficacy ≥ 60 lumens/W
- Exceptions
  - Traffic signals
  - Lighting within outdoor signs
  - Lighting used to illuminate public monuments or registered historic landmarks
  - If an occupancy sensor or motion sensor controls the lighting application

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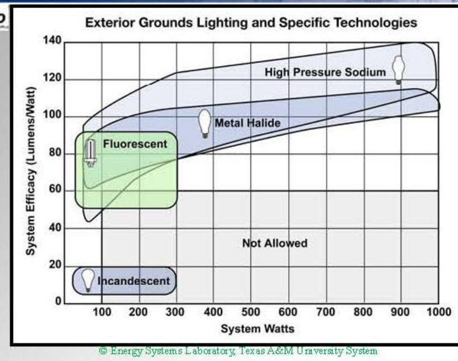
Lamp Efficacies



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Exterior Lighting Power
(Section 9.4.5)

- The total exterior lighting power allowance for all exterior building applications is the sum of the individual lighting power densities permitted in Table 9.4.5 for these applications plus an additional unrestricted allowance of 5% of that sum. Trade-offs are allowed only among exterior lighting applications listed as "Tradable Surfaces".

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Lighting Power Densities for Building Exteriors (Table 9.4.5)

Uncovered Parking Areas Parking lots and drives	**0.15** W/ft^2
Building Grounds	
Walkways < 10 feet wide	**1.0** W/lin. ft.
Walkways >10' wide, plazas, special feature areas	**0.2** W/ft^2
Stairways	**1.0** W/ft^2
Building Entrances and Exits	
Main entrances	**30** W/lin. ft. of door width
Other doors	**20** W/lin. ft. of door width
Canopies & Overhangs...Free standing or attached	**1.25** W/ft^2
Outdoor Sales	
Open areas (incl. vehicle sales lots)	**0.5** W/ft^2
Street frontage for vehicle sales lot (additional)	**20** W/lin. ft.
Note: The above items are "Tradable Surfaces" among themselves. The ones below are NOT.	
Building Facades	**0.2** W/ft^2 or **5.0** W/lin. ft. for ea. wall or surface
Automatic teller machines & night depositories	**270** W for 1st ATM plus **90** W per ATM
Entrances & gatehouse inspection stations	**1.25** W/ft^2 of uncovered area
Loading areas police, fire, ambulance, etc.	**0.5** W/ft^2 of uncovered area
Drive-up windows at fast-food restaurants	**400** W per drive-through
Parking near 24-hr retail entrances	**800** W per main entry

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Exterior Lighting Exceptions

Exempt when equipped with an independent control device:

- Specialized signal, directional, and marker lighting associated with transportation
- Advertising signage
- Lighting integral to equipment or instruments
- Theatrical lighting
- Athletic lighting, amusement park lighting
- Temporary lighting
- Highlighting Public monuments or Registered historic landmark structures or buildings

Building Area Method
(Section 9.5)

- Used for projects involving
  - An entire building
  - A single, independent, and separate occupancy in a multi-occupancy building
- **Gross lighted area** is multiplied by allowance from Table 9.5.1
- Limitations
  - Insensitive to specific space functions and room configurations
  - Generally is more restrictive
  - Does not apply to all building types - but "selection of a reasonably equivalent type" is permitted

Building Area Allowances
(Section 9.5.1)

There are 32 bldg types. Eight examples are shown here:

Hospital	- 1.2 W/ft^2
Library	- 1.3 W/ft^2
Manufacturing	- 1.3 W/ft^2
Museum	- 1.1 W/ft^2
Office	- 1.0 W/ft^2
Parking Garage	- 0.3 W/ft^2
Retail	- 1.5 W/ft^2
School	- 1.2 W/ft^2

Building Area Method
(Section 9.5.1)

Example:
Calculate Total Lighting Power Allowance using the Building Area Method:

A. An Office Building:
- 6 Floors
- Outside Dimensions 200' x 350'
- Office Building Power Allowance = 1.0 Watts/sq.ft.

Solution
- ✓ 200' x 350' = 70,000 sq. ft. per floor
- ✓ 6 Floors x 70,000 sq. ft per floor = 420,000 sq. ft.
- ✓ 420,000 sq. ft. x 1.0 watts per sq. ft = 420,000 Watts
- **Total Lighting Power Allowance = 420 kiloWatts ***

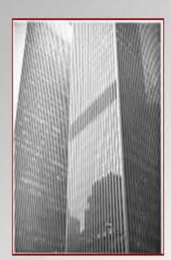
* 546,000 W when using 90.1-2001 (126,000 W saved.)

Space-by-Space Method
(Section 9.6)

- Identify different building types in your project
- Divide gross lighted area of the building into each of the space types
- Calculate lighting power allowance by multiplying area of space type by lighting power density for that specific space type
- Sum all the allowances
- Advantages
  - More flexible
  - Applicable to all building types
  - Accounts for room geometry (e.g., lighting needs of enclosed office vs. open office)

Space-by-Space Method
(Section 9.6.1)

There are 91 space types. Eleven examples are shown here:



Office Building Spaces:

- **Office Enclosed** - 1.1 W/ft^2
- **Office Open** - 1.1 W/ft^2
- **Conference** - 1.3 W/ft^2
- **Training** - 1.4 W/ft^2
- **Lobby** - 1.3 W/ft^2
- **Lounge** - 1.2 W/ft^2
- **Dining** - 0.9 W/ft^2
- **Food Prep** - 1.2 W/ft^2
- **Corridor** - 0.5 W/ft^2
- **Restroom** - 0.9 W/ft^2
- **Active Storage** - 0.8 W/ft^2

Additional Interior Lighting Power (Section 9.6.2)

Additional interior lighting power is allowed for specific space functions when using the space-by-space method:

- Decorative – 1.0 W/ft² in space used
- Lighting equipment installed in retail spaces specifically to highlight merchandise in specific space used, as follows:
  - Sales area for general consumer goods, 1.0 W/ft²
  - Vehicles, sporting goods, small electronics, 1.7 W/ft²
  - Furniture, clothing, cosmetics, artwork, 2.6 W/ft²
  - Fine jewelry, crystal & china, 4.2 W/ft²

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Space-by-Space Method (Section 9.6.2)

Example:
Calculate Total Lighting Power Allowance using the Space by Space Method:

A. Project is a Retail Building:
5000 sq. ft of Sales Area including
1000 sq. ft of jewelry counters
1000 sq. ft. of Active Storage Area
3 Enclosed Offices - 200 sq. ft. each
1 Conference Room - 400 sq. ft.
2 Rest Rooms - 150 sq. ft. each
Corridors - 6' wide x 25' long

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Space-by-Space Method (Section 9.6.2)

Solution, Step #1:
Identify the Watts per Square Foot allowed for Each Space

A Retail Building:
- ☐ Sales Area – 1.7 W/ft²
- ☐ Additional Power Allowances for Accent Lighting – 4.2 W/ft² of display
- ☐ Active Storage Area – 0.8 W/ft²
- ☐ Enclosed Offices - 1.1 W/ft²
- ☐ Conference Room - 1.3 W/ft²
- ☐ Rest Rooms – 0.9 W/ft²
- ☐ Corridors - 0.5 W/ft²

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Space-by-Space Method (Section 9.6.2)

Solution, Step #2:
Multiply W/ft² allowance by the area of each space. Add to calculate total power allowance.

Retail Building:
- ☐ Sales: 1.7 W/ft² x 5000 ft² = 8,500 Watts
- ☐ Active Storage Area: 0.8 W/ft² x 1000 ft² = 800 Watts
- ☐ Enclosed Offices: 1.1 W/ft² x (3) 200 ft² = 660 Watts
- ☐ Conference Room: 1.3 W/ft² x 400 ft² = 520 Watts
- ☐ Rest Rooms: 0.9 W/ft² x (2) 150 ft² = 270 Watts
- ☐ Corridors: 0.5 W/ft² x 6' x 25' = 75 Watts

LIGHTING POWER ALLOWANCE = **10,825 Watts**

Additional Power Allowance - Accent areas Only
4.2 W/ft² x 1000 ft² = **4,200 Watts**

TOTAL Int. Ltg. POWER ALLOWANCE = 15,025 Watts *

* 17,305 Watts when using 90.1-2001 (2,280 W saved.)

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Section 10 - Other Equipment

Section 10.2 – Electric Motors

- **Electric motors shall comply with the Energy Policy Act of 1992, as shown in Table 10.2. Motors not in the scope of EPA have no requirements in this section.**
- **Table shows minimum efficiency for general purpose motors.**

	Minimum Nominal Full-Load Efficiency (%)					
	Open Motors			Enclosed Motors		
Number of Poles ==>	2	4	6	2	4	6
Synchronous Speed (RPM) ==>	3600	1800	1200	3600	1800	1200
Motor Horsepower						
1	-	82.5	80.0	75.5	82.5	80.0
1.5	82.5	84.0	84.0	82.5	84.0	85.5
2	84.0	84.0	85.5	84.0	84.0	86.5
3	84.0	86.5	86.5	85.5	87.5	87.5
5	85.5	87.5	87.5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	88.5	89.5	89.5
10	88.5	89.5	90.2	89.5	89.5	89.5
15	89.5	91.0	90.2	90.2	91.0	90.2
20	90.2	91.0	91.0	90.2	91.0	90.2
25	91.0	91.7	91.7	91.0	92.4	91.7
30	91.0	92.4	92.4	91.0	92.4	91.7
40	91.7	93.0	93.0	91.7	93.0	93.0
50	92.4	93.0	93.0	92.4	93.0	93.0
60	93.0	93.6	93.6	93.0	93.6	93.6
75	93.0	94.1	93.6	93.0	94.1	93.6
100	93.0	94.1	94.1	93.6	94.5	94.1
125	93.6	94.5	94.1	94.5	94.5	94.1
150	93.6	95.0	94.5	94.5	95.0	95.0
200	94.5	95.0	94.5	95.0	95.0	95.0

* Nominal efficiencies shall be established in accordance with NEMA Standard MG1.

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Part VI.

Part VI: The ECB Methodology, Appendix G, Advanced Energy Design Guidelines (AEDG), tax incentives and software.

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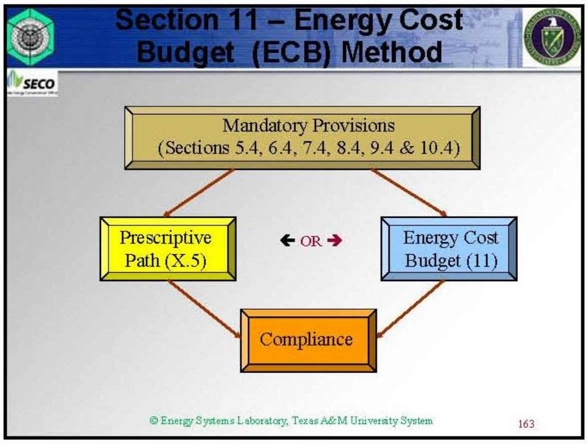
Section 11 – Energy Cost Budget (ECB) Method
SECO
Mandatory Provisions
(Sections 5.4, 6.4, 7.4, 8.4, 9.4 & 10.4)
Prescriptive Path (X.5)
← OR →
Energy Cost Budget (11)
Compliance
© Energy Systems Laboratory, Texas A&M University System
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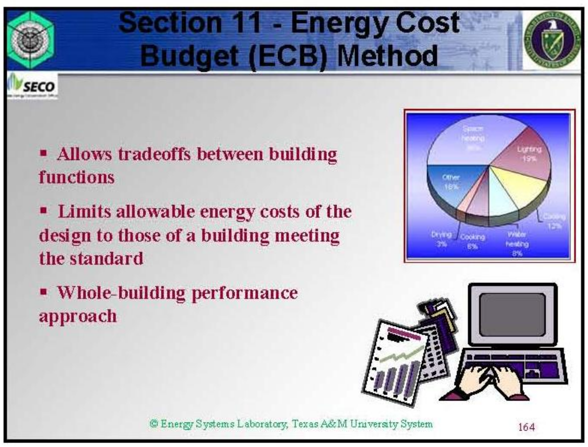
Section 11 - Energy Cost Budget (ECB) Method
SECO
▪ Allows tradeoffs between building functions
▪ Limits allowable energy costs of the design to those of a building meeting the standard
▪ Whole-building performance approach
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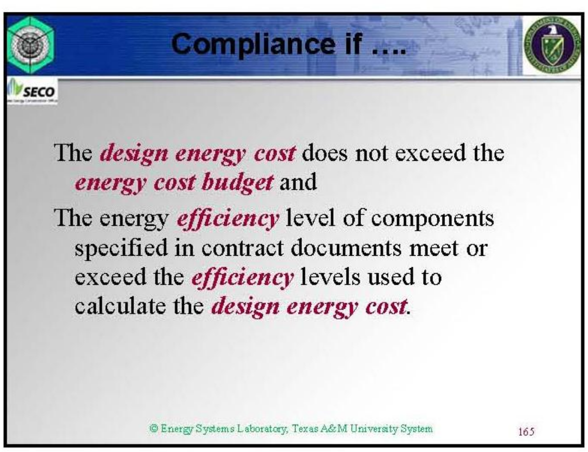
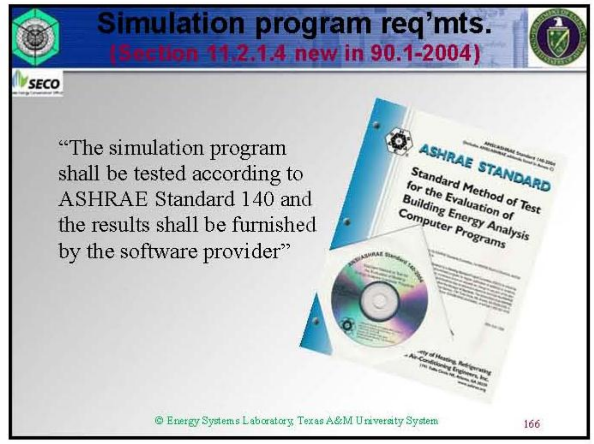

Compliance if ….
SECO
The design energy cost does not exceed the energy cost budget and
The energy efficiency level of components specified in contract documents meet or exceed the efficiency levels used to calculate the design energy cost.
© Energy Systems Laboratory, Texas A&M University System
165


Simulation program req'mts.
(Section 11.2.1.4 new in 90.1-2004)
SECO
"The simulation program shall be tested according to ASHRAE Standard 140 and the results shall be furnished by the software provider"
ASHRAE STANDARD
Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs
© Energy Systems Laboratory, Texas A&M University System
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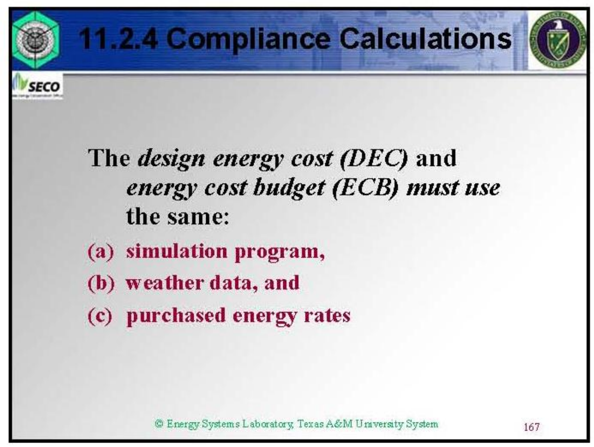
11.2.4 Compliance Calculations
SECO
The design energy cost (DEC) and energy cost budget (ECB) must use the same:
(a) simulation program,
(b) weather data, and
(c) purchased energy rates
© Energy Systems Laboratory, Texas A&M University System
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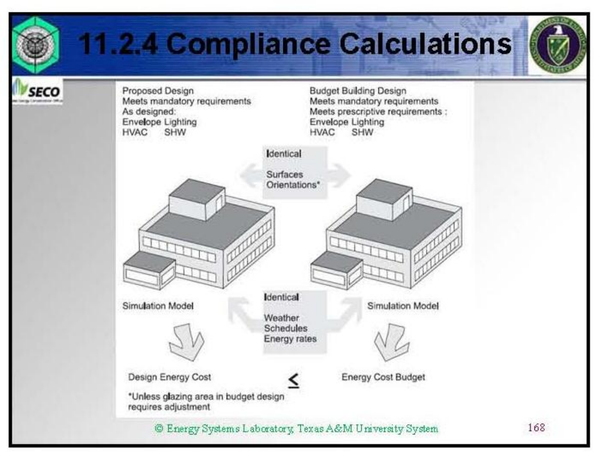
11.2.4 Compliance Calculations
SECO
Proposed Design
Meets mandatory requirements
As designed:
Envelope Lighting
HVAC SHW
Budget Building Design
Meets mandatory requirements
Meets prescriptive requirements :
Envelope Lighting
HVAC SHW
Identical
Surfaces
Orientations*
Simulation Model
Identical
Weather
Schedules
Energy rates
Simulation Model
Design Energy Cost
≤
Energy Cost Budget
*Unless glazing area in budget design requires adjustment
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Modeling Requirements for ECB
(DEC vs. ECB)

Must have modeling parity between DEC (Design Energy Cost & ECB (Energy Cost Budget) buildings w.r.t.:

1. Design Model
2. Additions & alterations
3. Space use classification
4. Schedules
5. Building envelope
6. Lighting
7. Thermal blocks –HVAC zones designed

1. Thermal blocks –HVAC zones not designed
2. Thermal blocks-multifamily
3. HVAC systems
4. Service hot water systems
5. Miscellaneous loads
6. Modeling exceptions
7. Modeling limitations to the simulation program

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11.3.2 HVAC Systems
(for budget building)

▪The HVAC system type and performance parameters for the budget building design shall be determined from:

▪the HVAC Systems map in Figure 11.3.2,

▪the system descriptions in Table 11.3.2A with nine (9) accompanying notes, and

▪**rules (a) through (j)** in section 11.3.2.

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HVAC System Map
(Section 11.3.2)

Condenser Cooling Source	Heating System Classification	Single Zone Residential System	Single Zone Non-Residential System	All Other
Water/ Ground	Electric Res	System 5	System 5	System 1
	Heat Pump	System 6	System 6	System 6
	Fossil Fuel	System 7	System 7	System 2
Air/ None	Electric Res	System 8	System 9	System 3
	Heat Pump	System 8	System 9	System 3
	Fossil Fuel	System 10	System 11	System 4

Budget System Type

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Budget System Descriptions
(Section 11.3.2A)

Syst.#	System Type	Fan control	Cooling type	Heating type
1	VAV w/ parallel fan-powered boxes	VAV	Chilled H_2O	Elec. Res.
2	VAV w/ reheat	VAV	Chilled H_2O	h.w. boiler
3	Pkg VAV w/ par f.p. box	VAV	DX	Elec. Res.
4	Pkg VAV w/ reheat	VAV	DX	h.w. boiler
5	2-pipe fan-coil	Const. vol.	Chilled H_2O	Elec. Res.
6	Water-source heat pump	Const. vol.	DX	Ht. pump boiler
7	4-pipe fan-coil	Const. vol.	Chilled H_2O	h.w. boiler
8	PTHP	Const. vol.	DX	Elec. Res.
9	Pkg rooftop heat pump	Const. vol.	DX	Elec. Res.
10	PTAC	Const. vol.	DX	h.w. boiler
11	Pkg rooftop a.c.	Const. vol.	DX	Fossil f. boiler

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Normative References
(Section 12)

▪ Normative (read "mandatory") reference documents

▪ Includes test methods, rating procedures, and other standards

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Appendices

NORMATIVE

A. Assembly U-, C-, and F-Factor Determination

B. Building Envelope Criteria

C . Envelope Trade-Off Methodology

D. Climate Data

INFORMATIVE

E. Informative References

F. Addenda Description Information

G. Performance Rating Method (new)

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Assembly U.F., C-Factor, & F-Factor Determination (Normative App. A)

- Includes pre-calculated U-factors, C-factors, and F-factors
  - Above-grade walls
  - Below-grade walls
  - Floors
  - Slab-on-grade floors
  - Opaque doors
  - Fenestration

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Building Envelope Climate Criteria (Normative Appendix B)

- Tables B-1, B-2, and B-3 contain eight (8) climate zones designations for U.S. counties, Canadian Provinces & cities and other foreign cities.
- Table B-4 lists the climate zone criteria in terms of HDD65 and CDD50 ranges.

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Envelope Trade-off Option (Normative Appendix C)

- This is the substance of Section 5.6, the gruesome details of how the envelope trade-off option is implemented.
- Explains the methodology in the ENVSTD trade-off software that allows trade-offs between roof and wall elements. The "metric" of trade-off is ultimately an energy dollar trade-off.

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Climatic Data (Normative Appendix D)

- 34 pages of climatic data for approx. 900 US, Canadian, and international cities.
- HDD_{65} and CDD_{50}
- Heating & cooling DB & WB design temperatures and the "number of hours between 8 am and 4 pm with T_{db} between 55° and 69°" for HVAC calculations

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Performance Rating Method (Informative Appendix G)

- The building performance rating method is a modification of the ECB method in Section 11 and is intended for use in rating the energy *efficiency* of building designs that exceed the requirements of the standard. It is not an alternative path for compliance; rather, it is for those wishing to quantify performance that substantially exceeds the requirements of Standard 90.1
- Like ECB, it requires the use of simulation software

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Tax Incentives

Energy-efficient Commercial building deduction.

This provision allows a tax deduction for energy-efficient commercial buildings that reduce annual energy and power consumption by 50% compared to the ASHRAE 90.1-2001 standard. The deduction would equal the cost of energy-efficient property installed during construction, with a maximum deduction of $1.80 per square foot of the building. Additionally, a partial deduction of 60 cents per square foot would be provided for building subsystems.

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Qualified Software for Federal Tax Deductions

Qualified Computer Software for Calculating Energy Savings for Purposes of the Energy-Efficient Commercial Building Tax Deduction under Internal Revenue Code § 179D.

Source: http://www1.eere.energy.gov/buildings/qualified_software.html

Software name and latest version submitted		Date DOE Received Latest Full Documentation
EnergyPlus	3.0.0.028	1/15/09
Green Building Studio	3.4	10/16/08
DOE 2.1E	119	7/2/08
DOE 2.1E-JJH	130	11/5/08
EnergyGauge Summit	3.14	12/21/07
EnerSim	07.11.30	12/6/07
Hourly Analysis Program (HAP)	4.34	8/10/07
Owens Corning (OC-CEC)	1.1	8/14/07
Trace 700	6.1.2.0	11/9/07
VisualDOE	4.1 build 0002	9/11/06

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Advanced Energy Design Guides

AEDGs available as of April '09
- Small Office Buildings
  - Up to 20,000 ft²
- Small Retail Buildings
  - Up to 20,000 ft²
- K-12 School Buildings
  - Elementary, Middle, and High School
- Small Warehouses and Self-Storage Buildings
  - Warehouses up to 50,000 ft²
  - Self-storage with unitary heating and air-conditioning

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Climate Zone 2

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Zone 2 Recommendations

Climate Zone 2 Recommendation Table

	Item	Component	Recommendation	How-To's in Chapter 4
Envelope	Roof	Insulation entirely above deck	R-15 c.i.	EN1-2, 17, 20-21
		Metal building	R-19	EN1, 3, 17, 20-21
		Attic and other	R-38	EN4, 17-18, 20-21
		Single rafter	R-38	EN5, 17, 20-21
		Surface reflectance/emittance	0.65 initial/0.86	EN1
	Walls	Mass (HC > 7 Btu/ft²)	R-7.6 c.i.	EN6, 17, 20-21
		Metal building	R-13	EN7, 17, 20-21
		Steel framed	R-13	EN8, 17, 20-21
		Wood framed and other	R-13	EN9, 17, 20-21
		Below-grade walls	No recommendation	EN10, 17, 20-21
	Floors	Mass	R-6.3 c.i.	EN11, 17, 20-21
		Steel framed	R-19	EN12, 17, 20-21
		Wood framed and other	R-19	EN12, 17, 20-21
	Slabs	Unheated	No recommendation	EN17, 19-21
		Heated	No recommendation	EN17, 19-21
	Doors	Swinging	U-0.70	EN15, 20-21
		Non-swinging	U-1.45	EN16, 20-21
	Vertical Glazing	Window to wall ratio (WWR)	20% to 40% max	EN23, 36-37
		Thermal transmittance	U-0.45	EN25
		Solar heat gain coefficient (SHGC)	N, S, E, W - 0.31 N only - 0.44	EN27-28
		Window orientation	$(A_N * SHGC_N + A_S * SHGC_S) > (A_E * SHGC_E + A_W * SHGC_W)$	A_x–Window area for orientation x EN26-32
		Exterior sun control (S, E, W only)	Projection Factor 0.5	EN24, 28, 30, 36, 40, 42 DL5-6
	Skylights	Maximum percent of roof area	3%	DL5-7, DL8, DL13
		Thermal transmittance	U-1.36	DL7, DL8, DL13
		Solar heat gain coefficient (SHGC)	0.19	DL8, DL13

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How-To's in Chapter 4

EN27 *Glazing* (Climate Zones: ❶ ❷ ❸ ❹ ❺ ❻)

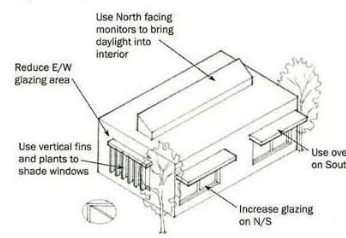
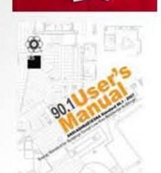


Figure 4-19. (EN27) Exterior sun control.

 185

Interpretations for Standard 90.1

- 90.1 Users Manuals
  - Provides much of the background
- Formal Interpretations
  - Formal written interpretations take time
- Informal Interpretations
  - Quick, informal answers to questions
- ASHRAE Manager of Standards (404) 636-8400



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Where to Get More Information

www.ashrae.org and local ASHRAE chapters
www.seco.cpa.state.tx.us/
www.energycodes.gov
www.nfrc.org
www.ansi.org
www.ari.org
www.icccampus.org
http://energysystems.tamu.edu

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Copies of the 90.1 Standards?

Standards 90.1-1999, 2001, 2004, 2007 and matching users manuals are available from ASHRAE.

ASHRAE

(404) 636-8400

www.ashrae.org

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DOE code compliance software

http://www.energycodes.gov

- Simplified Code Compliance Check
- COMcheck-EZ 3.6.0, by the U.S. DOE
- Embodies the choices of:
  - 90.1-1989
  - 90.1-1999
  - 90.1-2001
  - 90.1-2004
  - 90.1-2007
  - 1998 IECC
  - 2000 IECC
  - 2001 IECC
  - 2003 IECC
  - 2004 IECC
  - 2006 IECC
- For free download, visit the web site:
- http://www.energycodes.gov

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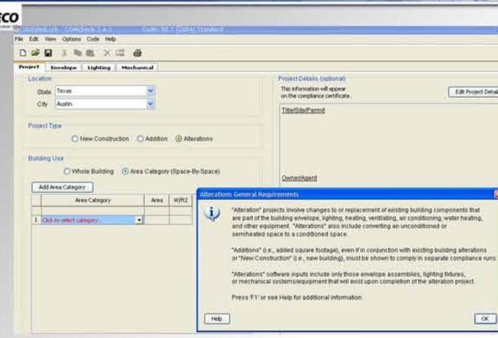
Calculation Tools- COMcheck



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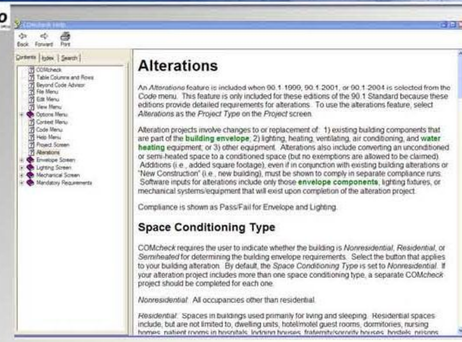
COMcheck (Alterations feature)



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ASHRAE Compliance Form

Simplified HVAC sample – top and bottom segments

HVAC Simplified Approach Option Part I

Project Name:	
Project Address:	Date:
City:	Zip:
HVAC System Designer of Record:	Telephone:
Contact Person:	Telephone:

Qualification

- The building is 2 stories or less in height and
- Exception: An energy recovery ventilation system is provided in accordance with the requirements in
- (j) Piping is insulated in accordance with Table 6.8.3. Insulation exposed to weather is suitable for outdoor service. Cellular foam

the supply air quantity at minimum outdoor air design conditions.

greater than 3/4 hp.

Equipment Efficiency

System Tag(s)	Mfg. & Model No.	Equipment Type	Heating			Cooling			
			Rated Capacity	Rated Efficiency	Minimum Efficiency	Rated Capacity	Rated Efficiency	Minimum Efficiency	Econ. Min. Efficiency

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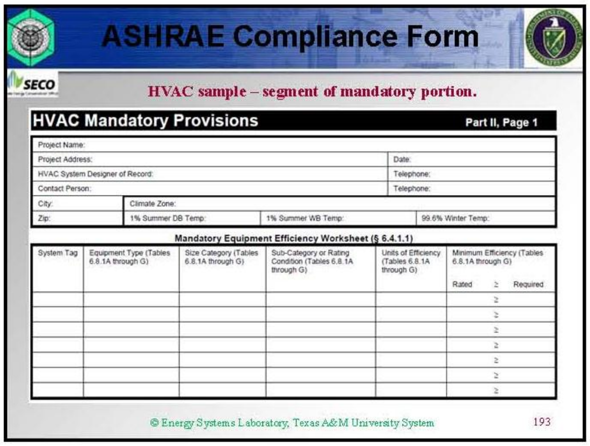
ASHRAE Compliance Form
SECO
HVAC sample – segment of mandatory portion.
HVAC Mandatory Provisions
Part II, Page 1
Project Name:
Project Address:
Date:
HVAC System Designer of Record:
Telephone:
Contact Person:
Telephone:
City:
Climate Zone:
Zip:
1% Summer DB Temp:
1% Summer WB Temp:
99.6% Winter Temp:
Mandatory Equipment Efficiency Worksheet (§ 6.4.1.1)
System Tag
Equipment Type (Tables 6.8.1A through G)
Size Category (Tables 6.8.1A through G)
Sub-Category or Rating Condition (Tables 6.8.1A through G)
Units of Efficiency (Tables 6.8.1A through G)
Minimum Efficiency (Tables 6.8.1A through G)
Rated ≥ Required
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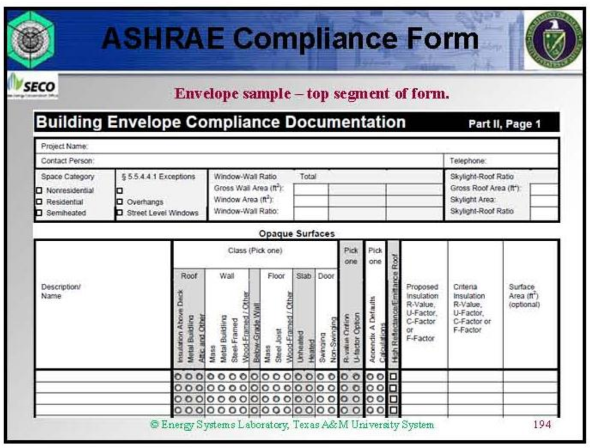
ASHRAE Compliance Form
SECO
Envelope sample – top segment of form.
Building Envelope Compliance Documentation
Part II, Page 1
Project Name:
Contact Person:
Telephone:
Space Category
Nonresidential
Residential
Semiheated
§ 5.5.4.4.1 Exceptions
Overhangs
Street Level Windows
Window-Wall Ratio
Total
Gross Wall Area (ft²):
Window Area (ft²):
Window-Wall Ratio:
Skylight-Roof Ratio
Gross Roof Area (ft²):
Skylight Area:
Skylight-Roof Ratio
Opaque Surfaces
Class (Pick one)
Pick one
Pick one
Description/ Name
Roof
Wall
Floor
Slab
Door
Insulation Above Deck
Metal Building
Attic and Other
Mass
Metal Building
Steel-Framed
Wood-Framed / Other
Below-Grade Wall
Mass
Steel Joist
Wood-Framed / Other
Unheated
Heated
Swinging
Non-Swinging
R-value Option
U-factor Option
Appendix A Defaults
Calculations
High Reflectance/Emittance Roof
Proposed Insulation R-Value, U-Factor, C-Factor or F-Factor
Criteria Insulation R-Value, U-Factor, C-Factor or F-Factor
Surface Area (ft²) (optional)
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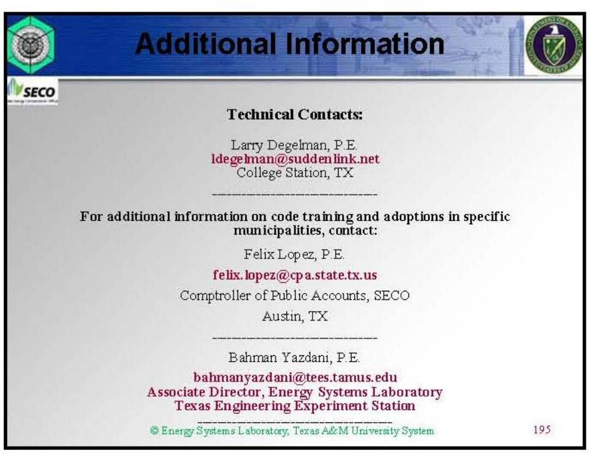
Additional Information
SECO
Technical Contacts:
Larry Degelman, P.E.
ldegelman@suddenlink.net
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Austin, TX
Bahman Yazdani, P.E.
bahmanyazdani@tees.tamus.edu
Associate Director, Energy Systems Laboratory
Texas Engineering Experiment Station
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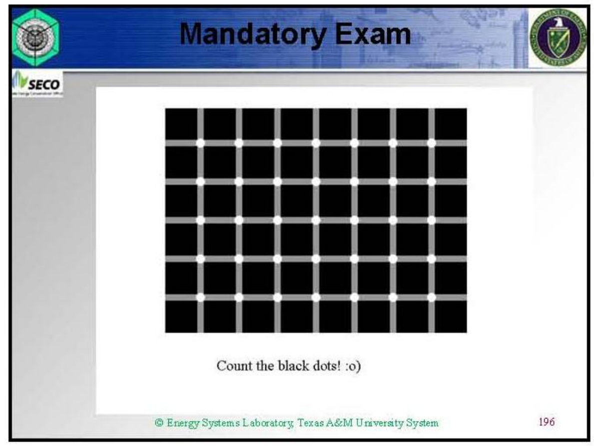
Mandatory Exam
SECO
Count the black dots! :o)
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Discussion / adjournment
SECO
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Six (6) ASHRAE 90.1-2007 workshops were presented in 2009.

TITLE	LOCATION	DATE	ATTENDEES
ASHRAE-90.1-2007	San Antonio	5/21/2009	17
ASHRAE-90.1-2008	Houston	10/15/2009	5
ASHRAE-90.1-2009	Arlington - UT	8/6/2009	54
ASHRAE-90.1-2010	Houston - MD And	5/21/2009	31
ASHRAE-90.1-2011	Austin - TFC	6/7/2009	25
ASHRAE-90.1-2012	Austin - UT PMCS	5/1/2009	52
		TOTAL	184

Presented by Larry Degelman, P.E., HBDP

May 21, 2009

ASHRAE- San Antonio

SECO

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14	Anthony Thomas	ST Phillips College	7039 San Pedro Ave.	San Antonio	TX	78216	athomas2@mail.accd.edu	210-486-7242	✓
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Presented by Larry Degelman, P.E. HBDP

October 15, 2009

CATEE 2009 - ASHRAE

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Presented by Larry Degelman, P.E., HBDP

May 1, 2009

ASHRAE - UT-PMCS Austin

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30	Kevin Echoes	UT Austin	1301 E. Dean Keeton	Austin	Tx	78722	kevin.echoes@austin.utexas.edu	512-475-8422	✓
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52	Felix Lopez	State energy Conservation Office	111 E. 17th St.	Austin	Tx	78711	felix.lopez@cpa.state.tx.us	512-463-1080	✓

Presented by Larry Degelman, P.E., HBDP
August 6, 2009

UT Arlington - ASHRAE

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Presented By Larry Degelman, P.E., HBDP									
21-May-09									
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June 7, 2009

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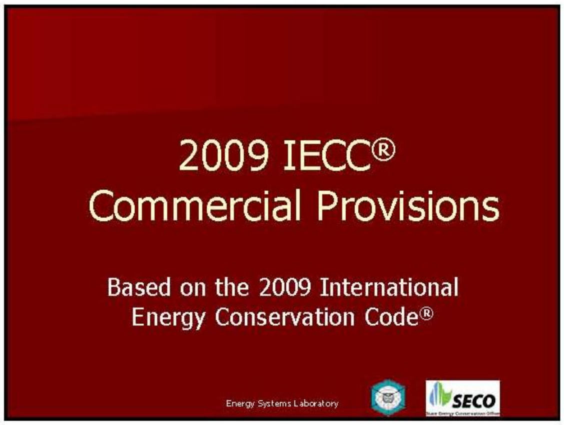
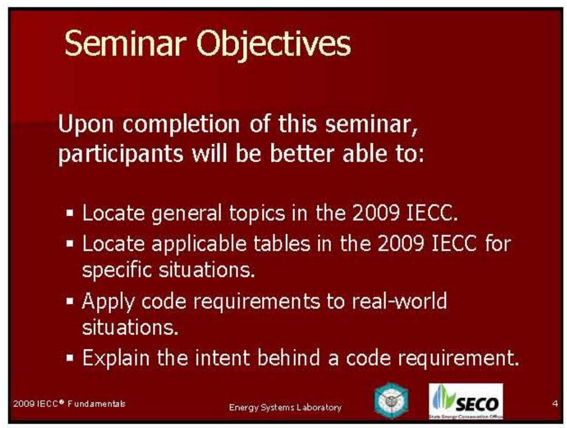
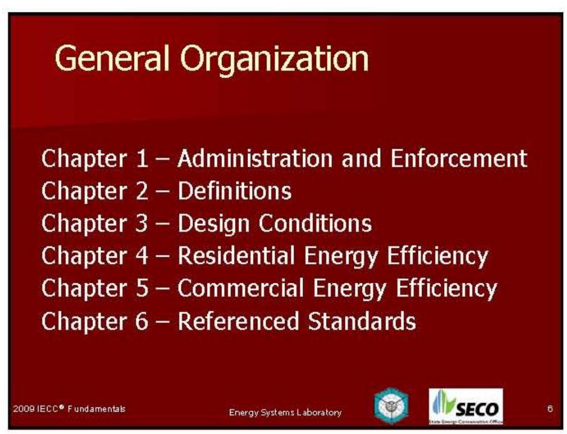
In 2009, the TERP group prepared for the trainings that were to be offered in 2010.







Objectives of the Code

The following are regulated:

- Building Envelope
- Mechanical Systems
- Electrical Systems
- Service Water Heating Systems

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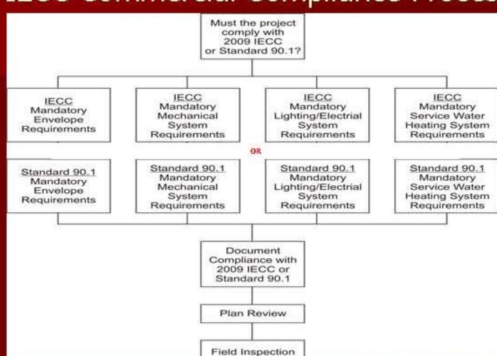
Code Compliance Process

1. Determine if the project must comply with the IECC
2. Determine if the project is residential or commercial
3. Compliance documentation
4. Plan reviewer is to ensure the documentation is clearly identified.
5. Confirm that energy-using features of the building are installed per the approved plans and documentation

2009 IECC® Fundamentals Energy Systems Laboratory SECO 8

IECC Commercial Compliance Process



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Chapter 1 Administration and Enforcement

Energy Systems Laboratory SECO

101 – Scope and General Requirements

- 101.2 – Scope

The provisions apply to several different project types:

- Newly conditioned space
- New construction in existing buildings
- Additions, alterations and repairs to existing buildings
- Mixed use buildings
- Change in occupancy

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101 – Scope and General Requirements

Newly Conditioned Space – New Buildings

New Construction - Hotel

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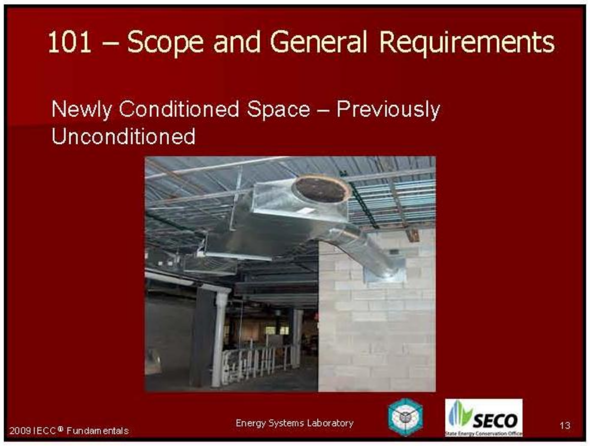
101 – Scope and General Requirements
Newly Conditioned Space – Previously Unconditioned
2009 IECC® Fundamentals
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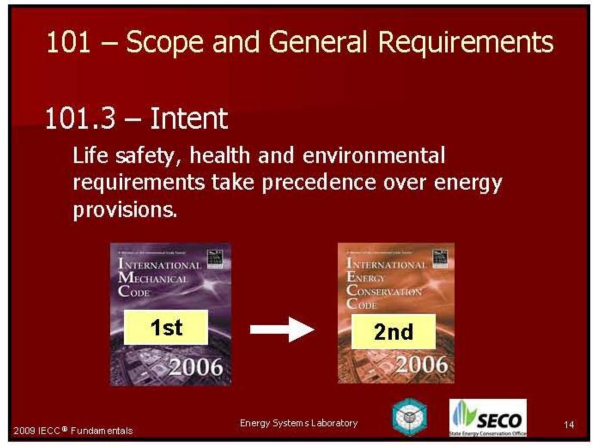
101 – Scope and General Requirements
101.3 – Intent
Life safety, health and environmental requirements take precedence over energy provisions.
International Mechanical Code
1st
2006
International Energy Conservation Code
2nd
2006
2009 IECC® Fundamentals
Energy Systems Laboratory
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101 – Scope and General Requirements
101.4 – Applicability
101.4.2 – Historic buildings
2009 IECC® Fundamentals
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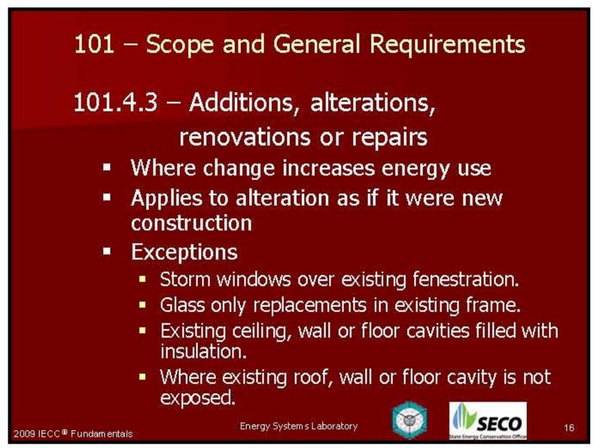
101 – Scope and General Requirements
101.4.3 – Additions, alterations, renovations or repairs
Where change increases energy use
Applies to alteration as if it were new construction
Exceptions
Storm windows over existing fenestration.
Glass only replacements in existing frame.
Existing ceiling, wall or floor cavities filled with insulation.
Where existing roof, wall or floor cavity is not exposed.
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Energy Systems Laboratory
SECO
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101 – Scope and General Requirements
101.4.3 – Additions, alterations, renovations or repairs (cont.)
Exceptions
Reroofing.
Replacement of existing doors
Alterations that replace less than 50% of the luminaires in a space provided that there is no increase in installed lighting power.
Alterations that replace only the bulb and ballast with the existing luminaires.
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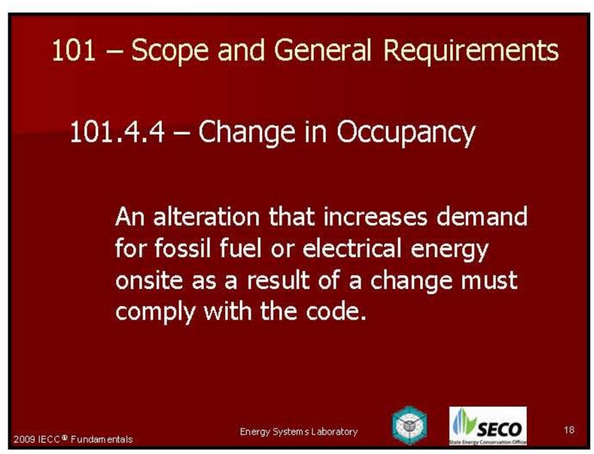
101 – Scope and General Requirements
101.4.4 – Change in Occupancy
An alteration that increases demand for fossil fuel or electrical energy onsite as a result of a change must comply with the code.
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101 – Scope and General Requirements

101.4.5 – Change in space conditioning

Any conditioned space that is altered to become conditioned space, must meet the requirements of the code.

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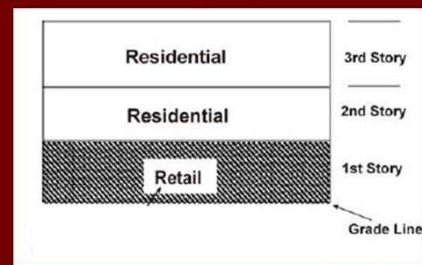
101 – Scope and General Requirements

101.4.6 – Mixed Occupancy Mixed-use building



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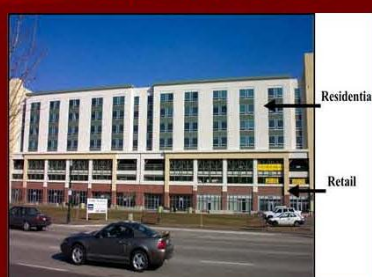
101 – Scope and General Requirements

101.4.6 – Mixed Occupancy Mixed-use building



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101 – Scope and General Requirements

101.5.2 – Low Energy Buildings

- Buildings designated as exempt include buildings that use less than 1 watt/ft^2 or 3.4 Btu/h ft^2 for space conditioning.
- Buildings, or portions thereof, that are not conditioned are exempt from thermal envelope requirements.

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102 Alternative Materials – Methods of Construction Design or Insulating Systems

102.1.1 – Above code program

- Authority to approve "above code" program is vested in the code official.
- Language does not guarantee alternative programs exceed the performance required by IECC
- Burden of proof to establish equivalency is on the applicant.

2009 IECC® Fundamentals — Energy Systems Laboratory — SECO

103 – Construction Documents

103.2 – Information on Construction Documents

- Level of efficiency used to demonstrate compliance with the code must be clearly identified
- Complete set of building plans with efficiency requirements clearly labeled

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103 – Construction Documents

Information about the following systems, which can be presented in a number of ways, should be included on the plans:

- Building envelope
- Mechanical system
- Lighting system
- Service water heating

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103 – Construction Documents

Information can be presented in a number of ways:

- On the drawings.
- On sections and in schedules.
- Through notes and callouts.
- Through supplementary worksheets or calculations.

2009 IECC® Fundamentals Energy Systems Laboratory SECO 26

103 – Construction Documents

103.3 Examination of documents

- This section of the code covers the examination of documents and the various types of approvals that the code official will deal with on both new and existing buildings.

2009 IECC® Fundamentals Energy Systems Laboratory SECO 27

104 - Inspections

The code states:

- All construction is subject to inspection.
- Construction shall not be concealed without inspection approval.
- A final inspection is required before occupancy.
- A building shall be reinspected when determined necessary by the code official.

2009 IECC® Fundamentals Energy Systems Laboratory SECO 28

106 – Referenced Standards

106.2 – Conflicting requirements

Code takes precedence when the requirements of the standard conflict with the requirements of the code

2009 IECC® Fundamentals Energy Systems Laboratory SECO 29

106 – Referenced Standards

106.2 – Other laws

The provisions of this code shall not be deemed to nullify any provisions of local, state, or federal law.

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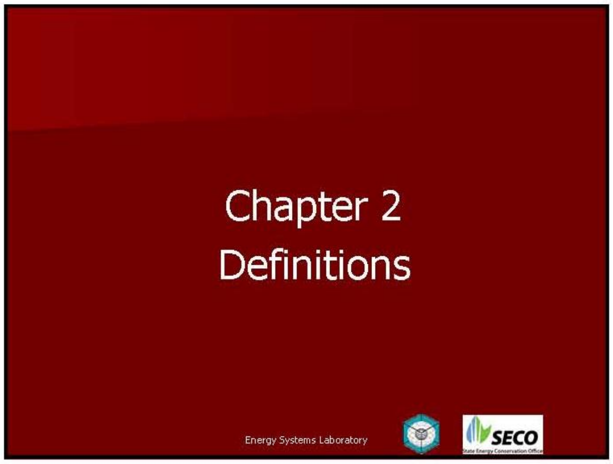
Chapter 2
Definitions
Energy Systems Laboratory
SECO


202 – General Definitions
Building Thermal Envelope
Exterior Wall
Commercial Building
Heated Slab
Conditioned Space
Residential Building
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Energy Systems Laboratory
SECO
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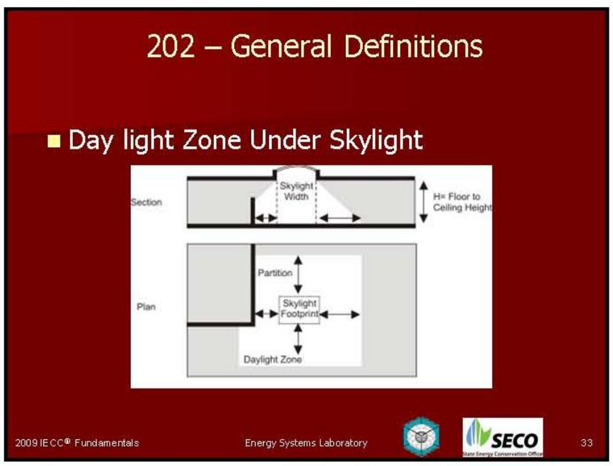
202 – General Definitions
Day light Zone Under Skylight
Section
Skylight Width
H= Floor to Ceiling Height
Partition
Plan
Skylight Footprint
Daylight Zone
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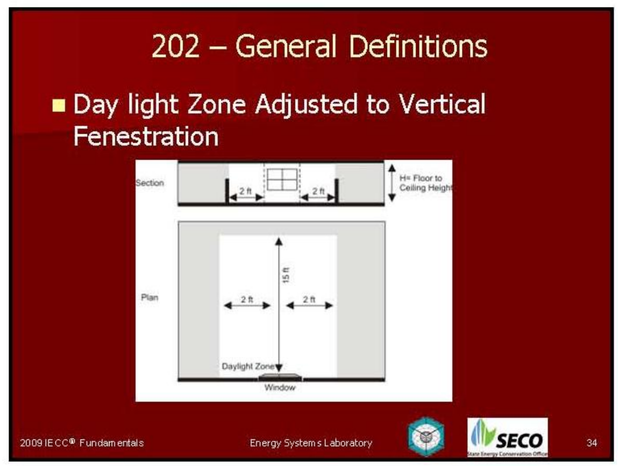
Energy Systems Laboratory
SECO
33


202 – General Definitions
Day light Zone Adjusted to Vertical Fenestration
Section
2 ft
2 ft
H= Floor to Ceiling Height
Plan
15 ft
Daylight Zone
Window
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Energy Systems Laboratory
SECO
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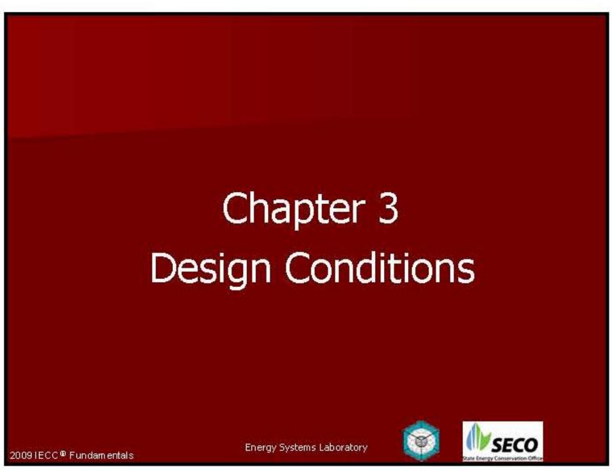
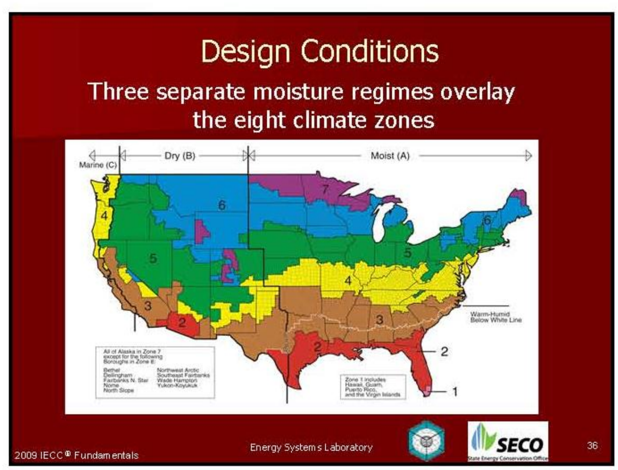

Chapter 3
Design Conditions
2009 IECC® Fundamentals
Energy Systems Laboratory
SECO


Design Conditions
Three separate moisture regimes overlay the eight climate zones
Marine (C)
Dry (B)
Moist (A)
Warm-Humid Below White Line
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Energy Systems Laboratory
SECO
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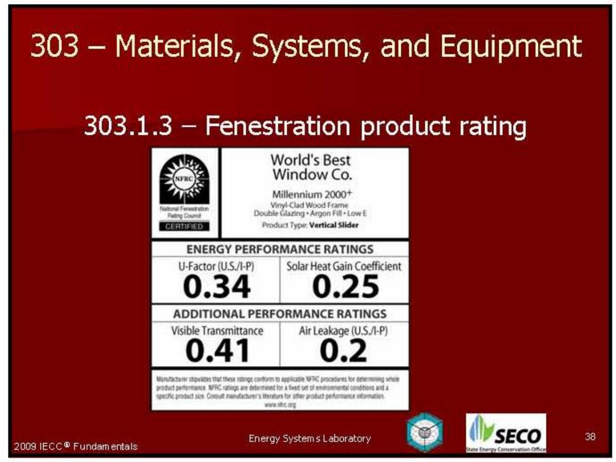
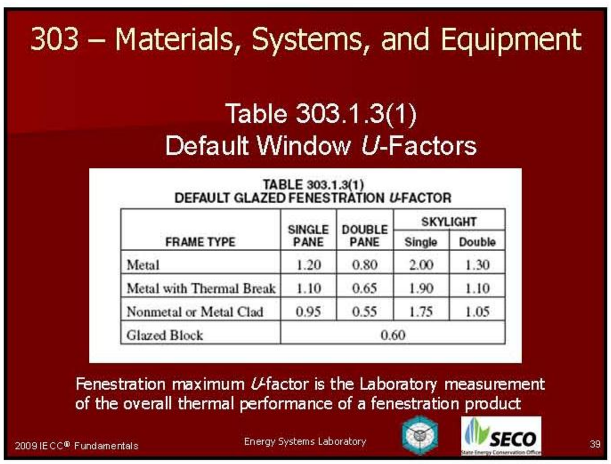
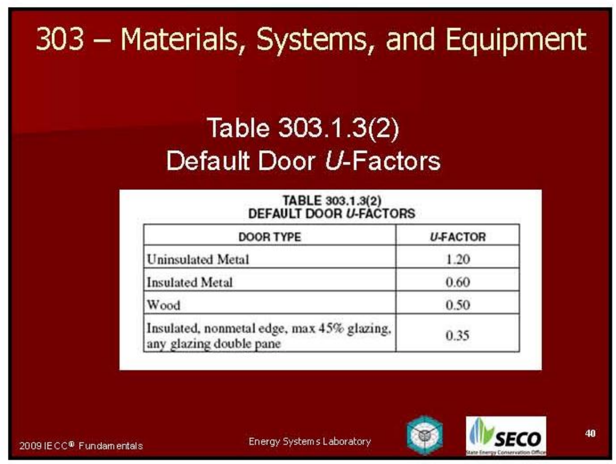


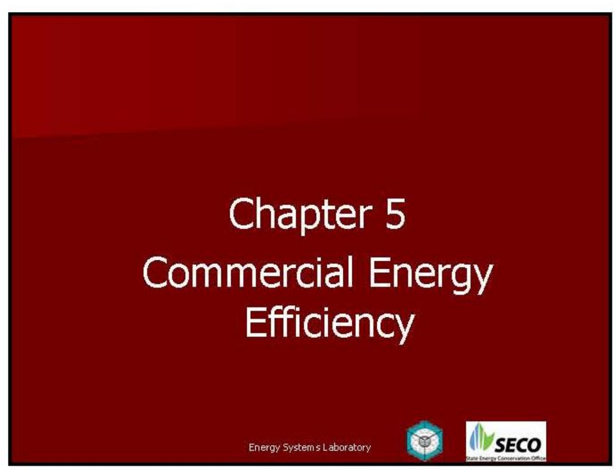


FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT Single	SKYLIGHT Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			



DOOR TYPE	*U*-FACTOR
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

SINGLE GLAZED Clear	SINGLE GLAZED Tinted	DOUBLE GLAZED Clear	DOUBLE GLAZED Tinted	GLAZED BLOCK
0.8	0.7	0.7	0.6	0.6



501 - General

501.1 – Scope

Standard 90.1

Commercial buildings shall meet either the requirements of ASHRAE/IESNA Standard 90.1 or the requirements contained in this chapter.

2009 IECC® Fundamentals Energy Systems Laboratory 43

501 - General

Structure of Standard 90.1-2007:

- Section 5 - Building Envelope
- Section 6 - Heating, Ventilating, and Air Conditioning
- Section 7 - Service Water Heating
- Section 8 - Power
- Section 9 – Lighting
- Appendix A Assembly U-factor, C-factor, and F-factor determination
- Appendix B Building Envelope Criteria
- Appendix C Trade-off Option
- Appendix D Climate Data

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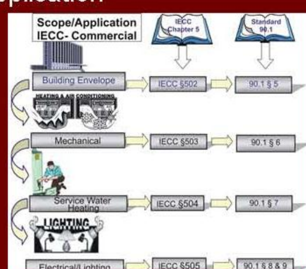
501 - General

501.2 – Application



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502 – Building Envelope Requirements

The building envelope requirements focus on three types of provisions:

- Air leakage
- Moisture protection
- Building envelope insulation and glazing requirements

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502 – Building Envelope Requirements

502.2 – Specific insulation requirements (prescriptive)

Based on:

- Climate zone
- Window wall ratio and
- Construction assembly

All components must meet or exceed building envelope requirements.

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502 – Building Envelope Requirements

Table 502.2(1) – Building envelope requirements – Opaque assemblies

- Determine the climate zone
- Each assembly will have maximum *U*-factor and SHGC requirements and minimum *R*-value requirements
- *R*-value requirements apply to the insulation only

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502 – Building Envelope Requirements

TABLE 502.1.2
BUILDING ENVELOPE REQUIREMENTS OPAQUE ELEMENT, MAXIMUM *U*-FACTORS

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above deck	U-0.063	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039
Metal buildings	U-0.065	U-0.065	U-0.055	U-0.055	U-0.055	U-0.055	U-0.055	U-0.055	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.049	U-0.035	U-0.035
Attic and other	U-0.034	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Walls, Above Grade																
Mass	U-0.058	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.90	U-0.80	U-0.080	U-0.071	U-0.071	U-0.071	U-0.071	U-0.052
Metal building	U-0.093	U-0.093	U-0.093	U-0.093	U-0.084	U-0.084	U-0.084	U-0.084	U-0.069	U-0.069	U-0.069	U-0.060	U-0.057	U-0.057	U-0.057	U-0.057
Metal framed	U-0.124	U-0.124	U-0.124	U-0.064	U-0.084	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.057	U-0.064	U-0.052	U-0.064	U-0.037
Wood framed and other	U-0.089	U-0.089	U-0.089	U-0.089	U-0.089	U-0.089	U-0.089	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.036	U-0.036
Walls, Below Grade																
Below-grade wall[a]	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-0.119	C-0.119	C-0.119	C-0.119	C-0.119	C-0.119	C-0.092	C-0.119	C-0.075
Floors																
Mass	U-0.322	U-0.322	U-0.107	U-0.087	U-0.107	U-0.087	U-0.087	U-0.074	U-0.074	U-0.064	U-0.064	U-0.057	U-0.064	U-0.051	U-0.057	U-0.051
Joist/Framing	U-0.282	U-0.282	U-0.052	U-0.052	—	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033
Slab-on-Grade Floors																
Unheated slabs	F-0.730	F-0.730	F-0.730	F-0.730	F-0.730	F-0.730	F-0.730	F-0.540	F-0.730	F-0.540	F-0.540	F-0.520	F-0.520	F-0.520	F-0.520	F-0.510
Heated slabs	F-1.020	F-1.020	F-1.020	F-1.020	F-0.900	F-0.900	—	F-0.860	F-0.860	F-0.860	F-0.860	F-0.688	F-0.830	F-0.688	F-0.688	F-0.688

a. When heated slabs are placed below-grade, below grade walls must meet the *F*-factor requirements for perimeter insulation according to the heated slab-on-grade construction.

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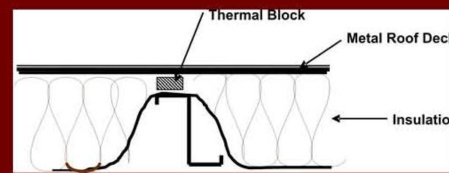
502 – Building Envelope Requirements

Metal buildings



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502 – Building Envelope Requirements

502.2.7 – Opaque doors

All are required to meet the *U*-factor requirement for doors as specified in Table 502.2(1).

Includes overhead coiling and metal roll-up doors used for conditioned loading docks.

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502 – Building Envelope Requirements

Table 502.3 – Building Envelope Requirements: Fenestration

The gross wall area includes:

- Above-grade walls
- Band and rim joists and spandrel area between floors
- Area of all doors and windows

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502 – Building Envelope Requirements

TABLE 502.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7	8
Vertical fenestration (40% maximum of above-grade wall)								
***U*-factor**								
Framing materials other than metal with or without metal reinforcement or cladding								
U-factor	1.20	0.75	0.65	0.40	0.35	0.35	0.35	0.35
Metal framing with or without thermal break								
Curtain wall/storefront *U*-factor	1.0	0.70	0.60	0.50	0.45	0.45	0.40	0.40
Entrance door *U*-factor	1.20	1.10	0.90	0.85	0.80	0.80	0.80	0.80
All other *U*-factor[a]	1.20	0.75	0.65	0.55	0.55	0.55	0.45	0.45
SHGC-all frame types								
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
SHGC: 0.25 ≤ PF < 0.5	0.33	0.33	0.33	NR	NR	NR	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR	NR	NR	NR
Skylights (3% maximum)								
U-factor	0.75	0.75	0.65	0.60	0.60	0.60	0.60	0.60
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

NR = No requirement.
PF = Projection factor (see Section 502.3.2).
a. All others includes operable windows, fixed windows and nonentrance doors.

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502 – Building Envelope Requirements

Skylights

- A skylight *U*-factor is based on the interior surface area of the entire skylight assembly, including glazing, sash, curbing and other framing elements.

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502 – Building Envelope Requirements

502.4 – Air Leakage (mandatory)

502.4.1 – Window and door assemblies

502.4.2 – Curtain wall, storefront glazing, and commercial entrance doors

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502 – Building Envelope Requirements

502.4.3 – Sealing of the building envelope

- Exterior joints around windows and door frames.
- Between wall sole plates, floors, and exterior wall panels.
- Openings for plumbing, electricity, refrigerant and gas lines in exterior walls, floors, and roofs.

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502 – Building Envelope Requirements

502.4.3 – Sealing of the building envelope

- Openings in the attic floor (such as where ceiling panels meet interior and exterior walls and masonry fireplaces).
- Service and access doors or hatches.
- All similar openings in the building envelope.

Sealing the building envelope reduces air infiltration in the building.

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502 – Building Envelope Requirements

502.4.3 – Sealing of the building envelope

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502.4.6 Loading Dock Weatherseals

- Equip cargo doors and loading dock doors with weatherseals
- Restrict infiltration

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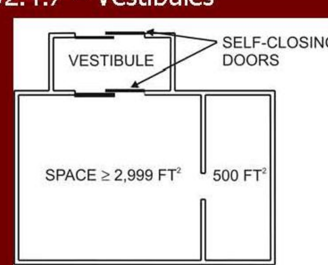
502 – Building Envelope Requirements

502.4.7 – Vestibules



For SI: 1 square foot = 0.0929 m².

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502 – Building Envelope Requirements

502.4.8 – Recessed luminaries

502 – Building Envelope Requirements

Moisture control (See IBC Sections 1405.3 and IRC Section R601.3)

- General requirements for control of moisture vapor entering the building have been relocated to the construction requirements of the IBC.

503 – Building Mechanical Systems

Seven key elements to ensure HVAC system design is efficient:

- Equipment efficiency
- Proper equipment sizing and selection
- Distribution losses
- Transmission losses
- Controls
- Free-cooling
- Heat recovery

503 – Building Mechanical Systems

- 503.2.1 – Calculation of heating and cooling loads
  - Designers must perform heating and cooling load calculations before sizing and selecting HVAC
  - HVAC systems must be sized based on the heating and cooling loads calculated in Section 503.2.1.
  - When the cooling load is predominant the system must be sized to not exceed that load.

503 – Building Mechanical Systems

503.2.2 – Equipment and system sizing

- "Shall not exceed the loads calculated."
- Equipment selected to meet space cooling loads must select capacity for heating based on smallest size within available equipment options.
- Standby equipment to have controls and devices to operate automatically when primary equipment is not operating.
- Multiple units with combined capacities that exceed design load shall have controls to sequence operation.

503 – Building Mechanical Systems

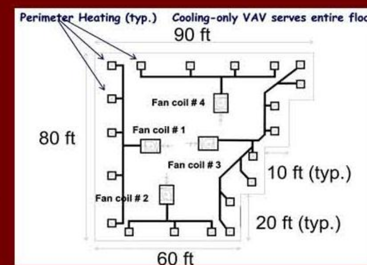
503.2.3 – HVAC equipment performance requirements

- Equipment efficiency

Table 503.2.3(7) – Water Chilling Packages, Minimum Efficiency Requirements

503.2.4 – HVAC system controls

503.2.4.1 – Thermostatic controls



503 – Building Mechanical Systems

503.2.4.4 – Shutoff damper controls

503.2.4.5 – Snow melt system controls

503.2.5 –Ventilation

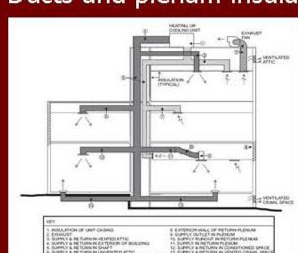
503 – Building Mechanical Systems

503.2.5.1 – Demand control ventilation

503.2.6 – Energy Recovery Ventilation System

503 – Building Mechanical Systems

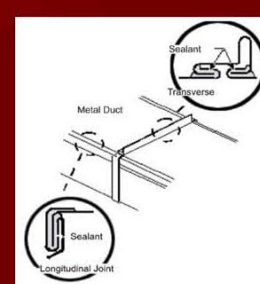
503.2.7 – Ducts and plenum insulation and sealing



Duct and Plenum Insulation

503 – Building Mechanical Systems

503.2.7.1 – Duct construction



Sealed Joints in Ductwork

503 – Building Mechanical Systems

503.2.8 – Piping insulation

- Piping serving as part of heating or cooling systems must be insulated according to Table 503.2.8.

TABLE 503.2.8
MINIMUM PIPE INSULATION
(thickness in inches)

FLUID	NOMINAL PIPE DIAMETER ≤ 1.5"	NOMINAL PIPE DIAMETER > 1.5"
Steam	1 1/2	3
Hot water	1 1/2	2
Chilled water, brine or refrigerant	1 1/2	1 1/2

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503 – Building Mechanical Systems

503.2.9 – HVAC system completion

503.2.9.1 – Air system balancing

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503 – Building Mechanical Systems

503.2.9.2 – Hydronic system balancing

- Individual hydronic heating and cooling coils to be equipped with means for balancing and pressure test connectors.

503.2.9.3 - Manuals

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503 – Building Mechanical Systems

503.3 – Simple HVAC systems and equipment

Simple systems are served by unitary or packaged HVAC equipment, each serving one zone and controlled by a single thermostat in the zone served. It also applies to two-pipe heating system, where no cooling system is installed.

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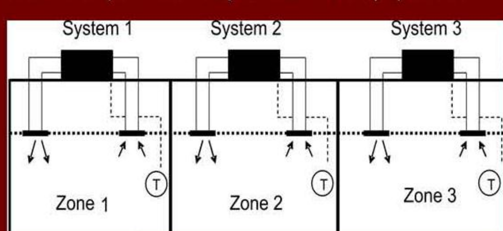
503 – Building Mechanical Systems

503.3 – Simple HVAC systems and equipment



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503 – Building Mechanical Systems

503.3.1 – Economizers

TABLE 503.3.1(1)
ECONOMIZER REQUIREMENTS

CLIMATE ZONES	ECONOMIZER REQUIREMENT
1A, 1B, 2A, 7, 8	No requirement
2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B	Economizers on all cooling systems ≥ 54,000 Btu/h[a]

For SI: 1 British thermal unit per hour = 0.293 W.

a. The total capacity of all systems without economizers shall not exceed 480,000 Btu/h per building, or 20 percent of its air economizer capacity, whichever is greater.

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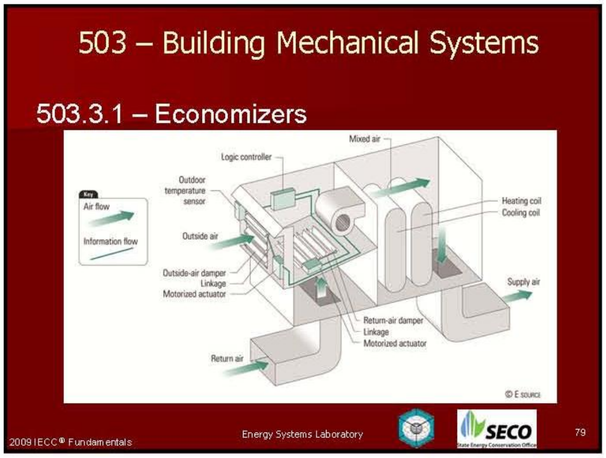
503 – Building Mechanical Systems
503.3.1 – Economizers
Mixed air
Logic controller
Outdoor temperature sensor
Key
Air flow
Information flow
Outside air
Outside-air damper
Linkage
Motorized actuator
Heating coil
Cooling coil
Supply air
Return-air damper
Linkage
Motorized actuator
Return air
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SECO
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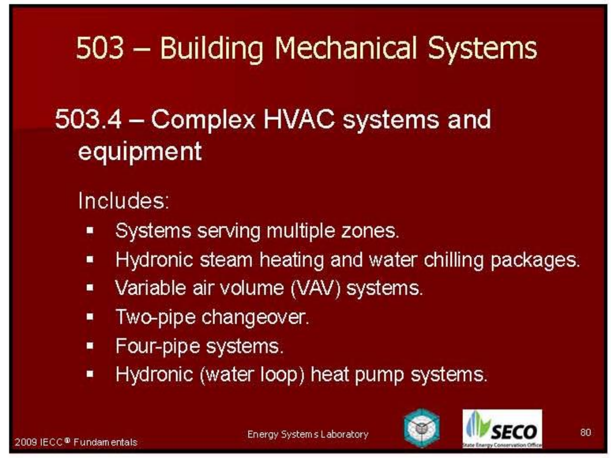
503 – Building Mechanical Systems
503.4 – Complex HVAC systems and equipment
Includes:
Systems serving multiple zones.
Hydronic steam heating and water chilling packages.
Variable air volume (VAV) systems.
Two-pipe changeover.
Four-pipe systems.
Hydronic (water loop) heat pump systems.
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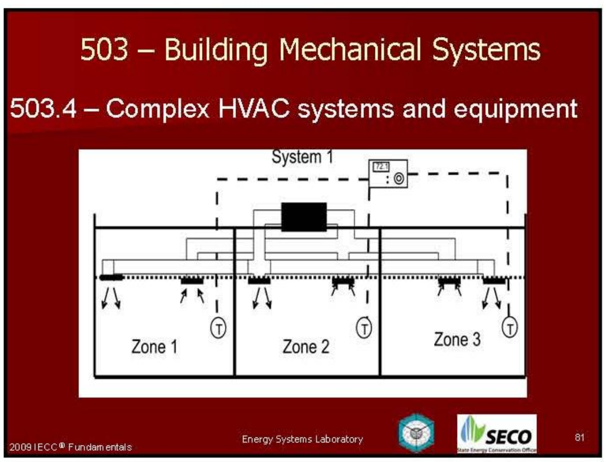
503 – Building Mechanical Systems
503.4 – Complex HVAC systems and equipment
System 1
Zone 1
Zone 2
Zone 3
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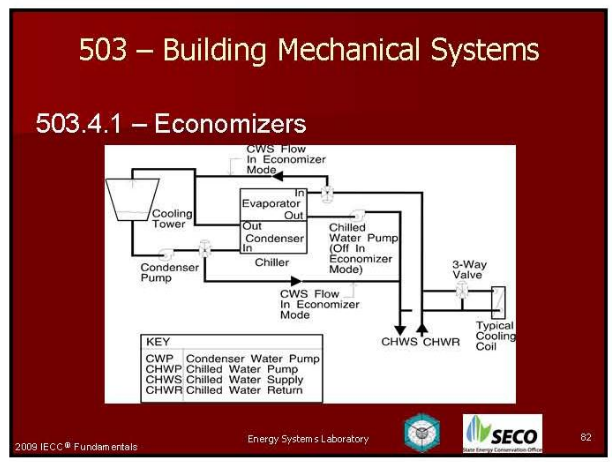
503 – Building Mechanical Systems
503.4.1 – Economizers
CWS Flow In Economizer Mode
Cooling Tower
Evaporator
In
Out
Condenser
Chiller
Chilled Water Pump (Off In Economizer Mode)
Condenser Pump
CWS Flow In Economizer Mode
3-Way Valve
Typical Cooling Coil
CHWS
CHWR
KEY
CWP Condenser Water Pump
CHWP Chilled Water Pump
CHWS Chilled Water Supply
CHWR Chilled Water Return
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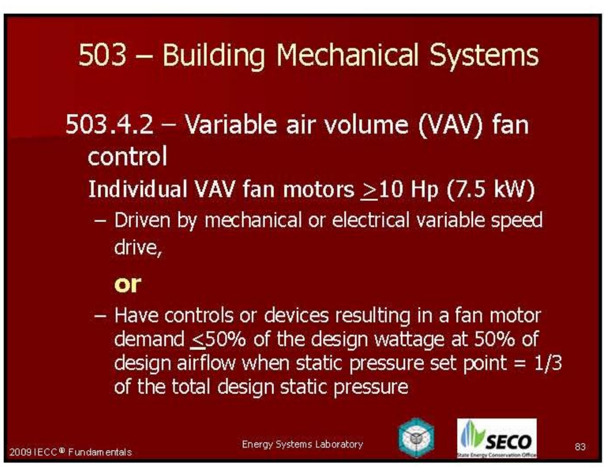
503 – Building Mechanical Systems
503.4.2 – Variable air volume (VAV) fan control
Individual VAV fan motors ≥10 Hp (7.5 kW)
– Driven by mechanical or electrical variable speed drive,
or
– Have controls or devices resulting in a fan motor demand ≤50% of the design wattage at 50% of design airflow when static pressure set point = 1/3 of the total design static pressure
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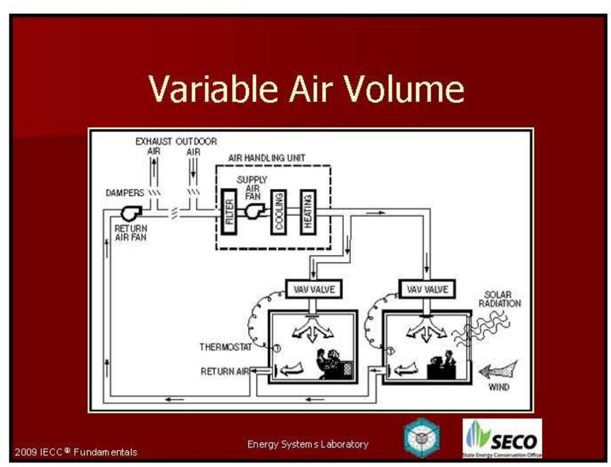
Variable Air Volume
EXHAUST AIR
OUTDOOR AIR
AIR HANDLING UNIT
SUPPLY AIR FAN
DAMPERS
RETURN AIR FAN
FILTER
COOLING
HEATING
VAV VALVE
VAV VALVE
SOLAR RADIATION
THERMOSTAT
RETURN AIR
WIND
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503 – Building Mechanical Systems

503.4.3 – Hydronic systems controls

503.4.3.1 – Three-pipe systems

503.4.3.2 – Two-pipe changeover system

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503 – Building Mechanical Systems

503.4.3.3 – Hydronic (water loop) heat pump systems

- Heat pumps connected to a water loop with central heat rejection and heat addition.
- Controls capable of providing 20ºF dead band outside air temperature between initiation of heat rejection and heat addition.

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503 – Building Mechanical Systems

503.4.3.4 – Part load controls

503.4.3.5 – Pump isolation

- Chilled water plants with multiple chillers must have the capability to reduce flow automatically when a chiller shut down.
- Boiler plants must have the capability to reduce flow automatically when a boiler is shut down.

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503 – Building Mechanical Systems

503.4.4 – Heat rejection equipment fan speed control

Fan Motors >7½ HP must have:

- Capability to operate fan at $\leq$ 2/3 of full speed or less, and
- Controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of heat rejection device.
- Exception: Factory installed heat rejection devices within HVAC equipment meeting equipment efficiency requirements.

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503 – Building Mechanical Systems

503.4.5 – Requirements for complex mechanical systems serving multiple zones

Supply air systems must be VAV systems. Controls are required to reduce primary air to each space before allowing:

- Reheating
- Recooling
- Mixing

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503 – Building Mechanical Systems

503.4.5 – Requirements for complex mechanical systems serving multiple zones

The primary air supply must be reduced by one of the following means before reheating, recooling, or mixing takes place:

- 30% of the maximum supply air flow to each zone.
- 300 cfm (142 L/s) where maximum flow rate is less than 10% of total fan system supply airflow rate.
- Minimum ventilation requirements of the International Mechanical Code® (IMC®).

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503 – Building Mechanical Systems

503.4.6 – Heat recovery for service water heating

Condenser heat recovery required for heating or reheating service hot water where

- Facility operates 24 hours a day, and
- Total installed heat capacity of water cooled systems >6,000,000 Btu/hr of heat rejection, and
- Design service water heating load exceed 1,000,000 Btu/h

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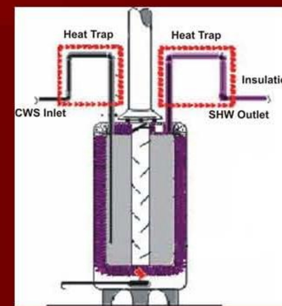
504 – Service Water Heating

504.4 – Heat traps

Manufactured Heat Trap Device



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504.5 – Pipe insulation

- Circulating systems
  - 1″ of insulation on piping
  - R-3.5/inch minimum
- Noncirculating systems
  - without integral heat traps
    - 1/2″ for first 8 feet
    - R-3.5/inch minimum

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504.6 – Hot water system controls

Automatic circulating hot water systems and heat trace

Turned off automatically or manually when the system is not in operation

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504.7 – Pools

Pool Heaters

- Readily accessible On/Off switch on heater
- Natural gas heaters shall not have continuously burning pilot lights

Time switches

- All – Heated and Unheated
  - Time clocks for circulation pumps according to a preset schedule
    - Exception
      - Where 24 hour operation is required for public health standards
      - Where pumps are required to operate solar and waste-heat recovery pool heating systems

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Pool Covers

- Pool Covers
  - Required on heated pools
    - 90^0F requires R-12 minimum
  - Vapor retardant, on or at the pool surface
  - Exception
    - 60% of the energy for heating is from site-recovered or site-solar energy

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505 – Electrical Power and Lighting Systems

Interior lighting plays a major role in the energy usage of a commercial building. An increased lighting load increases the capacity requirements for the cooling system.

The lighting requirements focus on these elements:

- Controls
- Light reduction methods
- Tandem wiring
- Interior and exterior lighting power

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505 – Electrical Power and Lighting Systems

505.1 – General

The lighting requirements apply to the design of:

- New lighting systems in conditioned or unconditioned spaces
- Altered components/systems as part of alteration

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505 – Electrical Power and Lighting Systems

505.1 – General

The lighting requirements apply to the design of:

- Altered system that increases the lighting load resulting from change of occupancy
- Exterior lighting systems

505.2.1 – Interior lighting controls

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505 – Electrical Power and Lighting Systems

505.2.2.1 – Light reduction controls

Light reduction controls differ from switching controls in that instead of turning the lights off after a period of inactivity, these controls lower the light output, and therefore the energy consumed, when areas are unoccupied or when there is suitable light supplied from another source such as windows or skylights.

These controls can be either "dimming" or "switching" depending on the light source you are controlling and the area being controlled.

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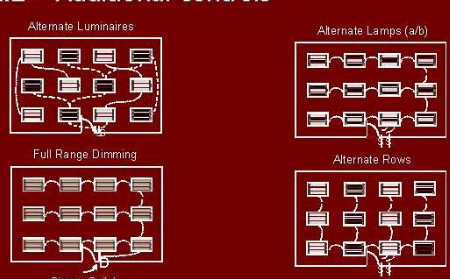
505 – Electrical Power and Lighting Systems

505.2.2 – Additional controls



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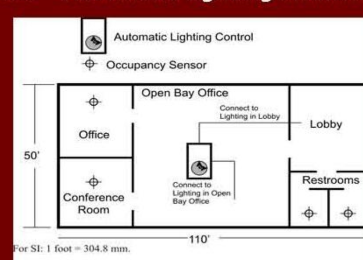
505 – Electrical Power and Lighting Systems

505.2.2.2 – Automatic lighting shutoff



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505 – Electrical Power and Lighting Systems

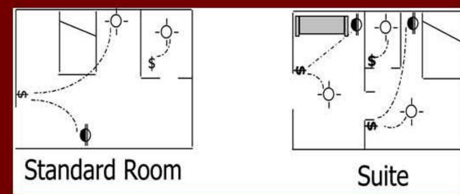
- 505.2.2.2.1 – Occupant override

If an automatic time switch control is installed, it must have an occupant override, be readily accessible, and have the following:

- Be in view of the lights.
- Manually operated.
- Two-hour override limit.
- Controls area less than 5,000 square feet.
- Holiday scheduling feature.

505 – Electrical Power and Lighting Systems

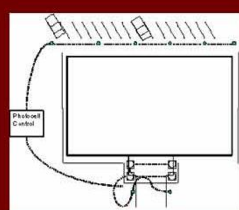
505.2.3 – Sleeping units



505 – Electrical Power and Lighting Systems

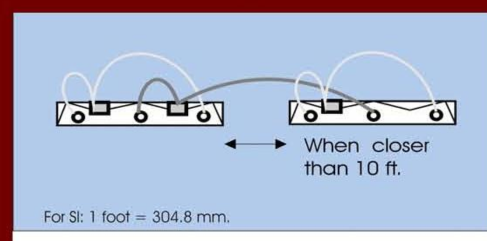
505.2.4 – Exterior lighting controls

- Must be controlled so they are automatically shut off during daylight hours
- Seven day/seasonal daylight program
- Minimum 4-hour battery backup



505 – Electrical Power and Lighting Systems

505.3 – Tandem wiring



505 – Electrical Power and Lighting Systems

505.4 – Exit signs

505 – Electrical Power and Lighting Systems

505.5 – Interior lighting power requirement

505.5.1 – Total connected interior lighting power

TABLE 505.5.2
INTERIOR LIGHTING POWER ALLOWANCES

LIGHTING POWER DENSITY	
Building Area Type[a]	**(W/ft²)**
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Healthcare—clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multifamily	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail[b]	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1

(continued)

TABLE 505.5.2—continued
INTERIOR LIGHTING POWER ALLOWANCES

LIGHTING POWER DENSITY	
Building Area Type[a]	**(W/ft²)**
Transportation	1.0
Warehouse	0.8
Workshop	1.4

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m².

a. In cases where both a general building area type and a more specific building area type are listed, the more specific building area type shall apply.

b. Where lighting equipment is specified to be installed to highlight specific merchandise in addition to lighting equipment specified for general lighting and is switched or dimmed on circuits different from the circuits for general lighting, the smaller of the actual wattage of the lighting equipment installed specifically for merchandise, or additional lighting power as determined below shall be added to the interior lighting power determined in accordance with this line item.

Calculate the additional lighting power as follows:

Additional Interior Lighting Power Allowance = 1000 watts + (Retail Area 1 × 0.6 W/ft²) + (Retail Area 2 × 0.6W/ft²) + (Retail Area 3 × 1.4 W/ft²) + (Retail Area 4 × 2.5 W/ft²).

where:

Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.

Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.

Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.

Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

Exception: Other merchandise categories are permitted to be included in Retail Areas 2 through 4 above, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display is *approved* by the authority having jurisdiction.

505 – Electrical Power and Lighting Systems

Additional Lighting Power Allowances

- Table 505.5.2, Note b – Merchandise Display
- Merchandise Display - (Note b)

The additional lighting allowance for merchandise display lighting applies to:

- Retail sales

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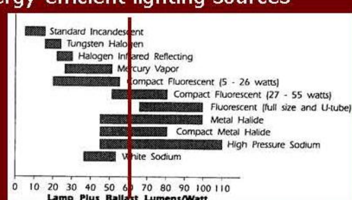
505 – Electrical Power and Lighting Systems

505.6.1 – Exterior building and grounds lighting

Energy-efficient lighting sources



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505 – Electrical Power and Lighting Systems

505.6.2 – Exterior building lighting power

Table 505.6.2 – Lighting Power Densities for Building Exteriors

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TABLE 505.6.2
LIGHTING POWER DENSITIES FOR BUILDING EXTERIORS

APPLICATIONS	LIGHTING POWER DENSITIES
Tradable Surfaces (Lighting Power Densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs, and outdoor sales areas may be traded.)	
Uncovered Parking Areas	
Parking Lots and drives	0.15 W/ft²
Building Grounds	
Walkways less than 10 feet wide	1.0 watts/linear foot
Walkways 10 feet wide or greater, plaza areas and special feature areas	0.2 W/ft²
Stairways	1.0 W/ft²
Building Entrances and Exits	
Main entries	30 watts/linear foot of door width
Other doors	20 watts/linear foot of door width
Canopies and Overhangs	
Canopies (free standing & attached and overhangs)	1.25 W/ft²
Outdoor Sales	
Open areas (including vehicle sales lots)	0.5 W/ft²
Street frontage for vehicle sales lots in addition to "open area" allowance	20 watts/linear foot
Nontradable Surfaces (Lighting Power Density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the Tradable Surfaces section of this table.)	
Building facades	0.2 W/ft² for each illuminated wall or surface or 5.0 Watts/linear foot for each illuminated wall or surface length
Automated teller machines and night depositories	270 watts per location plus 90 watts per additional ATM per location
Entrances and gatehouse inspection stations at guarded facilities	1.25 W/ft² of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces)
Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft² of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces)
Drive-up windows at fast food restaurants	400 watts per drive-through
Parking near 24-hour retail entrances	800 watts per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m².

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506 – Total Building Performance

506.1 – General

The Total Building Performance Method allows trade-offs among the building envelope, mechanical systems, and lighting systems in commercial buildings.




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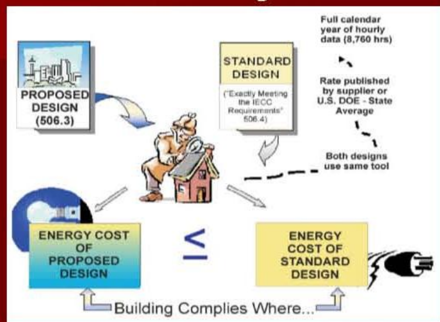
506 – Total Building Performance



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506 – Total Building Performance

506.4 – Documentation

The documentation that is required to support the analysis must provide the following information:

- Annual energy use and cost.
- List of building features.
- Output files showing energy use totals.
- Energy use by source and end use.
- Total hours that the space conditioning loads were not met.
- Software error messages or warnings.
- Written explanations of any error messages or warnings.

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Thanks for the Support of the

- State Energy Conservation Office (SECO)
  - especially Felix Lopez

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Energy Systems Laboratory

Questions and Answers

Energy Systems Laboratory

2009 IECC Fundamentals Residential Seminar

2009 IECC FUNDAMENTALS RESIDENTIAL

Based on the 2009 International Energy Conservation Code®

Energy Systems Laboratory
Texas Engineering Experiment Station
Texas A&M University System

KATHY MCKELVEY
CODES SPECIALIST
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SEMINAR GOAL

The goal of this seminar is for participants to apply the 2009 IECC in order to increase the efficient use of energy in the construction of new residential buildings and alterations to existing residential buildings.

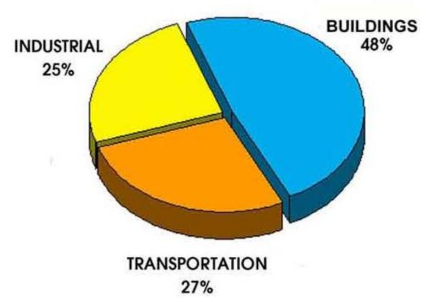
OBJECTIVES

Upon completion of this seminar, participants will be able to:

- Locate general topics in the 2009 IECC.
- Locate applicable tables in the 2009 IECC for specific situations.
- Apply code requirements to real-world situations.
- Explain the intent behind a code requirement.
- Identify borderline scenarios as compliant or noncompliant.
- Identify essential code compliancies for designing energy-efficient building thermal envelopes, energy-efficient mechanical design principles, and electrical lighting systems in residential construction.

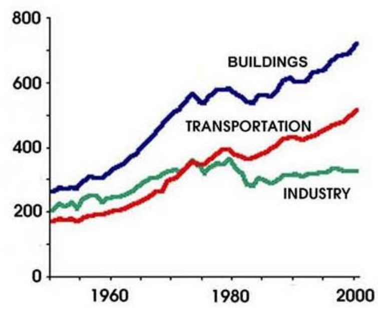
INTERNATIONAL ENERGY CONSERVATION CODE

- Recognized as the national model energy code of choice for U.S. cities, counties, and states that adopt codes
- Cited throughout Federal law for national private and public housing initiatives
- Serves as the basis for federal tax credits for energy efficient homes, energy efficiency standards for federal residential buildings, and manufactured housing



U.S. ENERGY CONSUMPTION

Source: Energy Information Administration Statistics (Architecture 2030)



CO2 EMISSIONS by SECTOR
(Million Metric Tons of Carbon)

Source: Energy Information Administration Statistics (Architecture 2030)

CODE COMPLIANCE PROCESS

1. Determine if the project must comply with the IECC.
2. Determine if the project is residential or commercial.
3. Compliance documentation.
4. Plan reviewer is to ensure the documentation is clearly identified.
5. Confirm that energy-using features of the building are installed per the approved plans and documentation.

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SCOPE

The code applies to:

- Eight global climate zones and three moisture regimes.
- Compliance assessment:
  - Prescriptive criteria (“Meet-or-Beat” and “Use-it or Lose-it” criteria)
  - Simulated Performance criteria (Energy simulation tools)

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THE FOLLOWING ARE REGULATED:

- Building Envelope
- Mechanical Systems
- Electrical Systems
- Service Water Heating Systems

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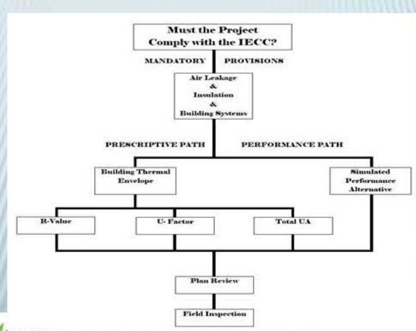
RESIDENTIAL COMPLIANCE PROCESS



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ORGANIZATION

Chapter 1 –	Administration and Enforcement
Chapter 2 –	Definitions
Chapter 3 –	Design Conditions
Chapter 4 –	Residential Energy Efficiency
Chapter 5 –	Commercial Energy Efficiency
Chapter 6-	Referenced Standards

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Chapter 1
Administration and Enforcement

101.2 SCOPE

The code applies to:

- Residential Buildings
  - One- and two-family dwellings, townhomes (not-IRC buildings)
  - Multi-family dwellings three stories or less in height
- Commercial Buildings
  - Multi-family dwellings four stories or greater in height

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101.3 – INTENT

- The IECC continues to emphasize both prescriptive and performance-related provisions for both commercial and residential buildings
- Provide flexibility to permit the use of innovative approaches and techniques

15

101.3 – INTENT

101.3 – Intent

Life safety, health and environmental requirements take precedence over energy provisions.

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101.4 – APPLICABILITY

The provisions apply to several different project types:

- Newly conditioned space
- Existing buildings - new construction - remodels
- Additions, alterations, renovations or repairs
- Change in occupancy or use
- Change in space conditioning
- Mixed occupancy

101 – NEWLY CONDITIONED SPACE

New buildings

New Construction - Hotel

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101.4 – APPLICABILITY

- 101.4.1 – Existing Buildings
- 101.4.2 – Historic Buildings

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101.4.3 – ADDITIONS, ALTERATIONS, RENOVATIONS OR REPAIRS

- Where change increases energy use.
- Applies to alteration as if it were new construction.
- Exceptions
  - Storm windows over existing fenestration
  - Glass only replacements in existing frame
  - Existing ceiling, wall or floor cavities filled with insulation
  - Where existing roof, wall or floor cavity is not exposed
  - Re-roofing where the sheathing is not disturbed
  - Replacement of existing door
  - Alterations that replace less that 50 percent of the luminaries
  - Alterations that replace only the bulb and ballast within the existing luminaries

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101 – SCOPE AND GENERAL REQUIREMENTS

101.4.4 – Change in Occupancy

An alteration that, increases the demand for fossil fuel, or electrical energy onsite as a result of a change, must comply with the code.

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101 – NEWLY CONDITIONED SPACE

Any unconditioned space that is altered to become conditioned space shall be required to be brought into full compliance with this code.

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101.4.6 – MIXED OCCUPANCY

101.4.6 – Commercial building

New Strip Shopping Center

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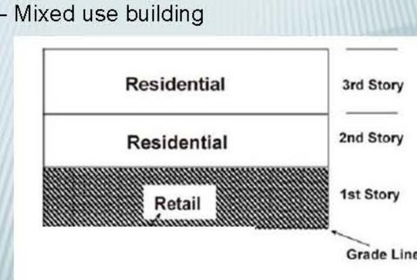
MIXED USE BUILDING

101.4.6 – Mixed use building



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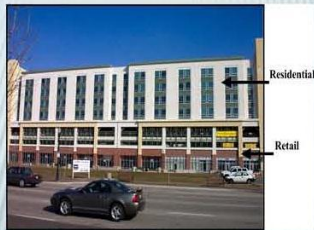
101.4.6 – EXAMPLE

101.4.6 – Mixed Occupancy Mixed-use building



Mixed Hotel/Motel and Commercial

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102.1.1 – ABOVE CODE PROGRAM

- Authority to approve "above code" program is vested in the code official.
- Language does not guarantee alternative programs to exceed the performance required by IECC.
- Burden of proof to establish equivalency is on the applicant.

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101.5.2 – LOW ENERGY BUILDINGS

Buildings that are exempt from the building envelope provisions are:

- Buildings with a peak design rate of energy use less than 3.4 Btu/h ft^2 or 1 watt/ft^2 of floor area for space conditioning purposes
- Those that do not contain conditioned space

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MATERIALS, SYSTEMS AND EQUIPMENT

Section 102 is now found in Section 303 - Materials, Systems and Equipment

Provisions applicable to the identification, installation, and use of energy efficient materials, systems and equipment are moved from Section 102 to Section 303. These are general technical requirements, not administrative requirements.

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103 – CONSTRUCTION DOCUMENTS

- Level of efficiency used to demonstrate compliance with the code must be clearly identified.
- Complete set of building plans with efficiency requirements clearly labeled.

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CONSTRUCTION DOCUMENT INFORMATION

Information about the following systems should be included on the plans:

- Building envelope
- Mechanical system
- Lighting system
- Service water heating

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103 – CONSTRUCTION DOCUMENTS

Information can be presented in a number of ways:

+ On the drawings.
+ On sections and in schedules.
+ Through notes and callouts.
+ Through supplementary worksheets or calculations.

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103.3 – PLAN REVIEW

103.3 Examination of documents

+ This section of the code covers the examination of documents, and the various types of approvals that the code official will deal with on both new and existing buildings

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104 - INSPECTIONS

The code states:

- All construction is subject to inspection.
- Construction shall not be concealed without inspection approval.
- A final inspection is required before occupancy.
- A building shall be re-inspected when determined necessary by the code official.

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106 – REFERENCED STANDARDS

106.2 – Conflicting requirements

Code takes precedence when the requirements of the referenced standards, in Chapter 6, with the requirements of the code.

106.2 – Other laws

The provisions of this code shall not be deemed to nullify any provisions of local, state, or federal law.

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LET'S TAKE A…

…ten-minute break.

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Chapter 2 Definitions

202 – GENERAL DEFINITIONS

- Building Thermal Envelope
- Commercial Building
- Conditioned Space
- Exterior Wall
- Residential Building

NEW DEFINITIONS

- Air barrier
- *C*-factor (thermal conductance)
- Daylight zone
- Demand control ventilation
- Entrance door
- Fan systems
- *F*-factor
- High-efficiency lamps
- Nameplate horsepower

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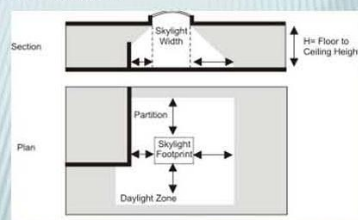
DAY LIGHT ZONE

- Under Skylight



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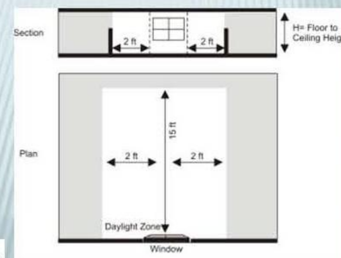
DAY LIGHT ZONE

- Adjusted to Vertical Fenestration



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REVISED DEFINITIONS

- Labeled
- Listed
- Storefront

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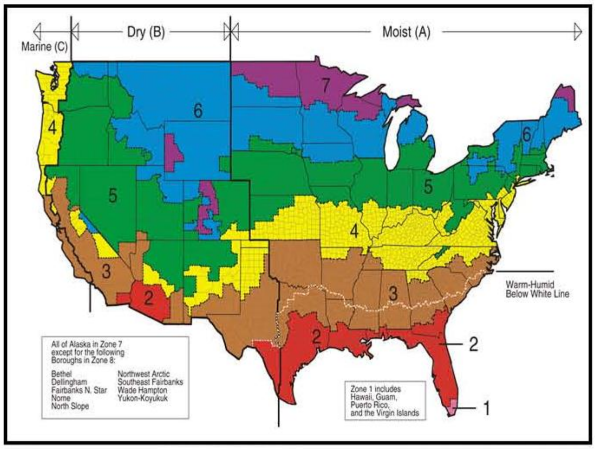
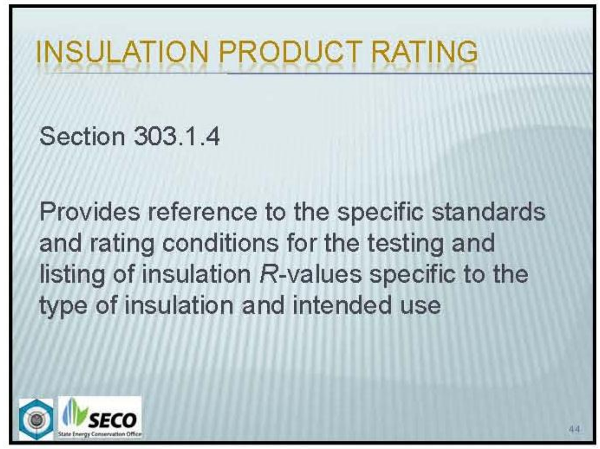
Chapter 3
Design Conditions





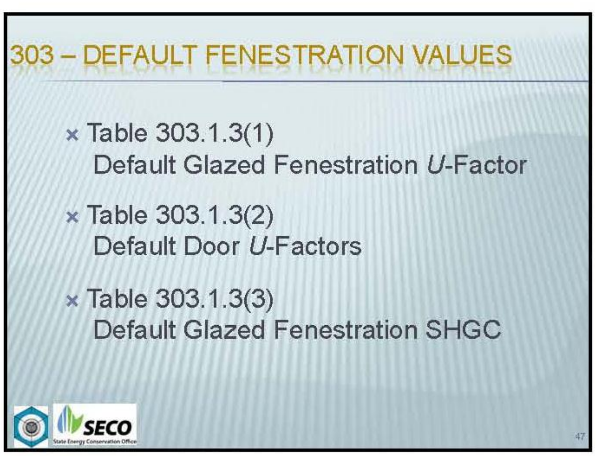


TABLE 302.1.3(1)
DEFAULT GLAZED FENESTRATION *U*-FACTOR

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT Single	SKYLIGHT Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			

TABLE 303.1.3(2) DOOR VALUES

TABLE 303.1.3(2)
DEFAULT DOOR *U*-FACTORS

DOOR TYPE	*U*-FACTOR
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

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TABLE 303.1.3(3) – SOLAR HEAT GAIN COEFFICIENT

TABLE 303.1.3(3)
DEFAULT GLAZED FENESTRATION SHGC

SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
Clear	Tinted	Clear	Tinted	
0.8	0.7	0.7	0.6	0.6

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Chapter 4
Residential Energy Efficiency

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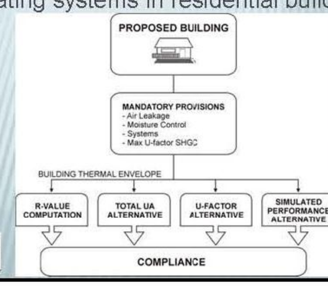
RESIDENTIAL ENERGY EFFICIENCY

Contains requirements for the building envelope, heating and cooling systems, and water heating systems in residential buildings.



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COMPLIANCE METHODS

402.1.2 – Compliance by *R*-value computation

Table 402.1.1 – Insulation and Fenestration Requirements by Component

402.1.3 – *U*-factor alternative

Table 402.1.3 – Equivalent *U*-Factors

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TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	1.2	0.75	0.30	30	13	3/4	13	0	0	0
2	0.65[j]	0.75	0.30	30	13	4/6	13	0	0	0
3	0.50[j]	0.65	0.30	30	13	5/8	19	5/13[f]	0	5/13
4 except Marine	0.35	0.60	NR	38	13	5/10	19	10 /13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	20 or 13+5[h]	13/17	30[g]	10/13	10, 2 ft	10/13
6	0.35	0.60	NR	49	20 or 13+5[h]	15/19	30[g]	15/19	10, 4 ft	10/13
7 and 8	0.35	0.60	NR	49	21	19/21	38[g]	15/19	10, 4 ft	10/13

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. R-19 batts compressed into a nominal 2 × 6 framing cavity such that the *R*-value is reduced by R-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

c. "15/19" means R-15 continuous insulated sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulated sheathing on the interior or exterior of the home. "10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure 301.1 and Table 301.1.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

j. For impact rated fenestration complying with Section R301.2.1.2 of the *International Residential Code* or Section 1608.1.2 of the *International Building Code*, the maximum *U*-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.

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TABLE 402.1.3
EQUIVALENT *U*-FACTORS[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR[d]	CRAWL SPACE WALL *U*-FACTOR[c]
1	1.20	0.75	0.035	0.082	0.197	0.064	0.360	0.477
2	0.65	0.75	0.035	0.082	0.165	0.064	0.360	0.477
3	0.50	0.65	0.035	0.082	0.141	0.047	0.091[c]	0.136
4 except Marine	0.35	0.60	0.030	0.082	0.141	0.047	0.059	0.065
5 and Marine 4	0.35	0.60	0.030	0.057	0.082	0.033	0.059	0.065
6	0.35	0.60	0.026	0.057	0.060	0.033	0.050	0.065
7 and 8	0.35	0.60	0.026	0.057	0.057	0.028	0.050	0.065

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.
b. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of 0.17 in Zone 1, 0.14 in Zone 2, 0.12 in Zone 3, 0.10 in Zone 4 except Marine, and the same as the frame wall *U*-factor in Marine Zone 4 and Zones 5 through 8.
c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure 301.1 and Table 301.2.
d. Foundation *U*-factor requirements shown in Table 402.1.3 include wall construction and interior air films but exclude soil conductivity and exterior air films. *U*-factors for determining code compliance in accordance with Section 402.1.4 (total UA alternative) of Section 405 (Simulated Performance Alternative) shall be modified to include soil conductivity and exterior air films.

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DETERMINING COMPLIANCE

An assembly *U*-factor must be calculated for each applicable assembly type proposed for the project.

The ASHRAE *Handbook of Fundamentals* is an excellent source of information on how to calculate an assembly *U*-factor.

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CALCULATING ASSEMBLY *U*-FACTORS

- The calculation must include the effects of framing.
- A *R*-value must be determined for each different material in the assembly.
- The *R*-values are then totaled to determine the total *R*-value through each thermal path of the assembly.
- The total *R*-values are then converted to *U*-factors by taking the reciprocal of the *R*-value.
- An area-weighted average *U*-factor is calculated for the wall system that takes into account the effects of framing.

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SAMPLE CALCULATION—WALLS

$$U_{ow} = \frac{(U_{wl} \times A_{wl}) + (U_{w2} \times A_{w2}) + \ldots}{A_{w1} + A_{w2} + \ldots}$$

Where
- U_{wl} = *U*-factor of opaque wall number 1
- A_{wl} = Area of opaque wall number 1
- U_{w2} = *U*-factor of opaque wall number 2
- A_{w2} = Area of opaque wall number 2

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402.1.4 – TOTAL UA ALTERNATIVE

- The building envelope design is permitted to deviate from *R*-values or *U*-factors in Tables 402.1.1 or 402.1.3, respectively, provided the total thermal transmittance (*UA*) is the same or less as the very same building envelope geometry designed to code

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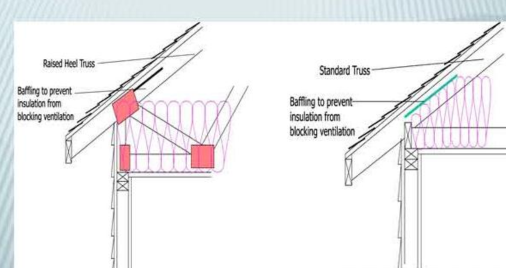
402.2.1 – CEILINGS WITH ATTIC SPACES



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EXAMPLES OF WALL INSULATION
Blown-in, Loose-fill Insulation
Unfaced-batt Insulation
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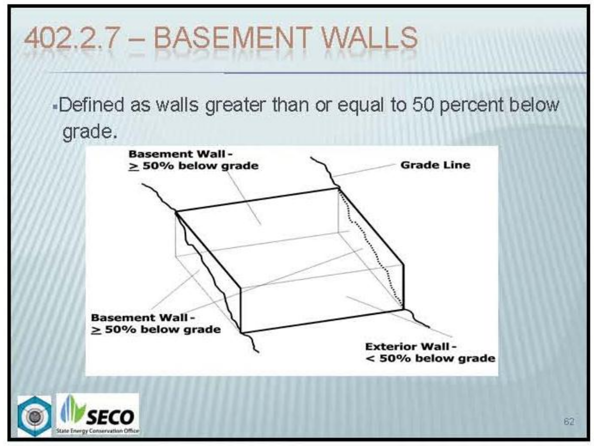
402.2.7 – BASEMENT WALLS
Defined as walls greater than or equal to 50 percent below grade.
Basement Wall - ≥ 50% below grade
Grade Line
Basement Wall - ≥ 50% below grade
Exterior Wall - < 50% below grade
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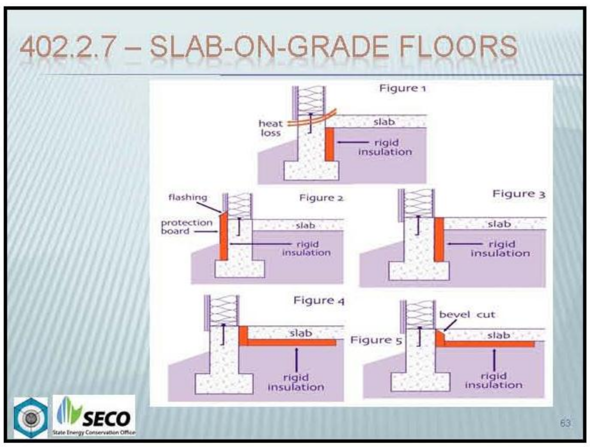
402.2.7 – SLAB-ON-GRADE FLOORS
Figure 1
heat loss
slab
rigid insulation
flashing
protection board
Figure 2
slab
rigid insulation
Figure 3
slab
rigid insulation
Figure 4
slab
rigid insulation
bevel cut
Figure 5
slab
rigid insulation
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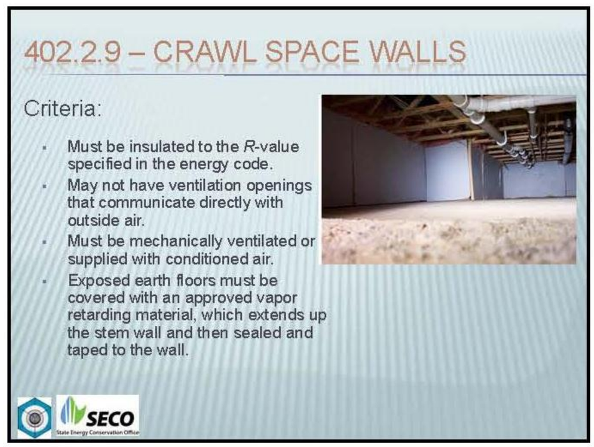
402.2.9 – CRAWL SPACE WALLS
Criteria:
Must be insulated to the R-value specified in the energy code.
May not have ventilation openings that communicate directly with outside air.
Must be mechanically ventilated or supplied with conditioned air.
Exposed earth floors must be covered with an approved vapor retarding material, which extends up the stem wall and then sealed and taped to the wall.
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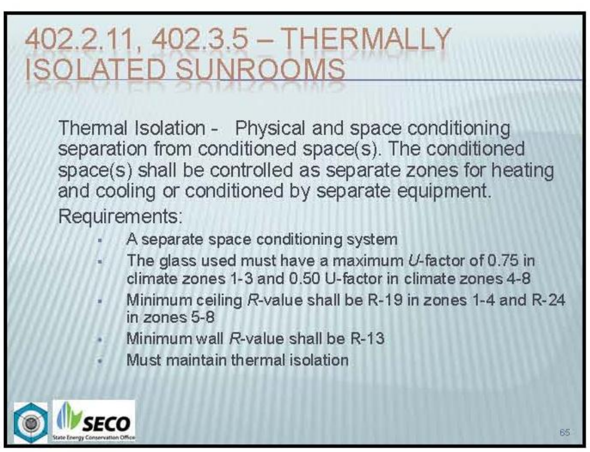
402.2.11, 402.3.5 – THERMALLY ISOLATED SUNROOMS
Thermal Isolation - Physical and space conditioning separation from conditioned space(s). The conditioned space(s) shall be controlled as separate zones for heating and cooling or conditioned by separate equipment.
Requirements:
A separate space conditioning system
The glass used must have a maximum U-factor of 0.75 in climate zones 1-3 and 0.50 U-factor in climate zones 4-8
Minimum ceiling R-value shall be R-19 in zones 1-4 and R-24 in zones 5-8
Minimum wall R-value shall be R-13
Must maintain thermal isolation
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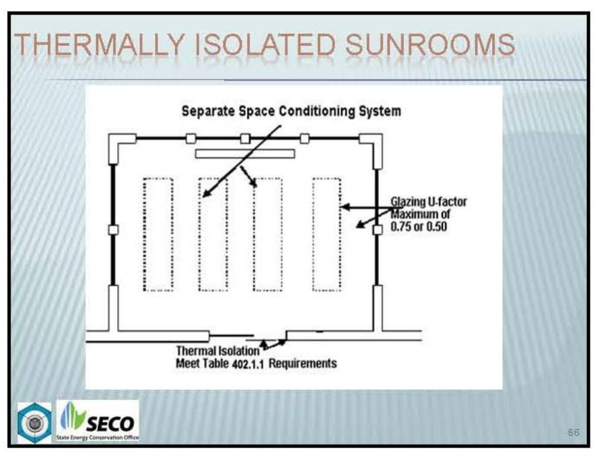
THERMALLY ISOLATED SUNROOMS
Separate Space Conditioning System
Glazing U-factor Maximum of 0.75 or 0.50
Thermal Isolation
Meet Table 402.1.1 Requirements
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402.3 – FENESTRATION

402.3.1 *U*-factor

- Area weighted average *U*-factors and SHGCs may be used to comply with Table 402.1.1.
- Up to 15 ft^2 of glazed fenestration per dwelling unit can be exempted from *U*-factor and SHGC requirements.

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402.3.2 – GLAZED FENESTRATION SHGC

The SHGC measures how well a window or translucent product blocks heat caused by sunlight. SHGC is expressed as a number between 0 and 1. The lower the number, the lower the amount of heat that passes into the building through the glazing.

Fenestration must be rated using NFRC 200 or a default SHGC value is to be assigned from Table 303.1.3(3).

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EXEMPTION

- 402.3.3 Glazed fenestration SHGC & 402.3.3 Glazed fenestration exemption
  - Up to 15 square feet (1.4 m2) of glazed fenestration per dwelling unit can be exempted from *U*-factor and SHGC requirements
- 402.3.4 Opaque door
  - One hinged opaque door up to 24 square feet (2.22m2) is also exempt
- 402.3.6 Replacement fenestration
  - Replacement windows and skylights must comply with the fenestration *U*-factor requirements of Table 402.1.1.

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402.4, 402.5, 402.6, 403 – MANDATORY REQUIREMENTS

402.4 – Air Leakage (mandatory)

402.4.1 – Building thermal envelope

402.4.2 – Air Sealing and Insulation

- Building envelope air tightness and insulation shall be demonstrated in one of two ways.

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402.4.2.1 TESTING OPTION

Requires testing at specific air changes per hour at a specific air pressure

There are seven requirements:

1. Exterior windows and doors, fireplaces and stove doors closed, but not sealed
2. Dampers shall be closed but not sealed
3. Interior doors open
4. Exterior openings for continuous ventilation systems and heat recovery ventilators closed and sealed
5. Heating and cooling systems turned off
6. HVAC shall not be sealed
7. Supply and return registered shall not be sealed.

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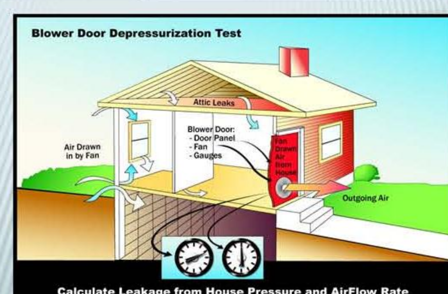
BLOWER DOOR TESTING



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402.4.2.2 VISUAL INSPECTION OPTION

- Follows Table 402.4.2 and can include an independent third party if approved by the code official.

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402.4.3 – FIREPLACES

New wood-burning fireplaces shall have gasketed doors and outdoor combustion air.

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402.4.4 – FENESTRATION AIR LEAKAGE

Sets the testing requirements for air leakage rates in windows, skylights and sliding glass and swinging doors.

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402.4.5 – RECESSED LIGHTING

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402.5 – MAXIMUM FENESTRATION U-FACTOR AND SHGC (MANDATORY)

Limits the maximum area-weighted *U*-factor and SHGC that can be traded-off among opaque envelope components for the purpose of envelope compliance.

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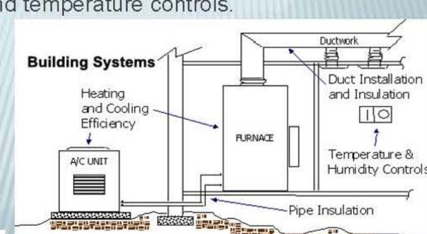
403 – BUILDING SYSTEMS

The building systems addressed, consist of a heating and/or cooling system, a distribution system, and temperature controls.



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THERMOSTAT AND CONTROLS

- 403.1.1 – Programmable Thermostat
- 403.1.2 – Heat pump supplementary heat (Mandatory)

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403.2 – DUCTS

- 403.2.1 – Insulation
  - Supply ducts in attics shall be R-8 min
  - All other ducts shall be R-6 min
  - Exception
    - Ducts located completely inside the building thermal envelope (don't have to be insulated)
- 403.2.2 – Sealing
  - All ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed in accordance with Section M1601.4.1 IRC
  - Duct tightness shall be verified by testing
    - Post-construction or rough-in
    - The test is not required where the air handler and entire duct system are located within conditioned space

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403.4 – CIRCULATING HOT WATER

- Insulation
  - All hot water piping shall be R-2 min
- Controls
  - Automatic controls OR
  - Readily accessible manual switch

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403.6 AND 403.7 – SIZING, MULTIPLE UNITS

- Sizing
  - Heating and cooling equipment shall be sized in accordance with Section M1401.3 of the IRC
    - Use Design conditions specified in IECC Chapter 3.
    - "Part IV—Mechanical" of the IRC refers specifically to the Air Conditioning Contractors of America (ACCA) Manual J for building loads (IRC Section M1401.3).
    - "Part IV—Mechanical" of the IRC refers specifically to the Air Conditioning Contractors of America (ACCA) Manual S for sizing equipment (IRC Section M1401.3).
- Multiple Units
  - All systems serving multiple dwelling units shall comply with Sections 503 and 504 in lieu of Section 403

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OVERSIZING = SHORT CYCLING

Oversized Air Conditioning Equipment Results in Short Cycling

Impacts of oversizing are:

- Reduces equipment life
- Reduces efficiency (SEER)
- Results in poor dehumidification
- Reduces filter effectiveness

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403.8 - SNOWMELT SYSTEMS

- Snow and ice-melting equipment controls
  - Automatic controls capable of shutting down the system when:
    - The pavement temperature is above 50°F and no precipitation is falling AND
    - An automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F

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403.9 – POOLS

Energy conservation requirements are required for residential pools the same as commercial pools. These include pool heaters, time switches to control circulation pumps, heaters, and vapor retardant pool covers

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403.9.1 POOL HEATERS

- All pool heaters shall be equipped with a readily accessible on-off switch to allow shutting off the heater without adjusting the thermostat setting. Pool heaters fired by natural gas shall not have continuously burning pilot lights.

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403.9.2 TIME SWITCHES.

- Time switches to automatically turn on and off heaters and pumps according to a preset schedule, shall be installed on swimming pool heaters and pumps. The two exceptions address public health standards and circumstances where the pumps serve pools with solar-waste-heat recovery heating systems.

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403.9.3 POOL COVERS

- Heated pools shall have a vapor-retardant pool cover on or at the water surface
- Pools heated to more than 90ºF shall have a R-12 min value pool cover
- Exception
  - Pools deriving over 60 percent of the energy for heating from site-recovered or solar energy source

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404.1 - LIGHTING EQUIPMENT

A minimum of fifty percent of the lamps in permanently installed lighting fixtures shall be high-efficiency lamps.

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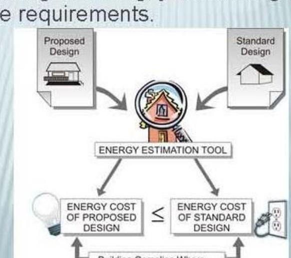
405 – SIMULATED PERFORMANCE ALTERNATIVE

An energy estimation tool is used to compare the energy use of the proposed design with that of the standard design building, just meeting the minimum code requirements.



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405.4 – DOCUMENTATION

A comparative compliance report which clearly depicts the annual energy costs of both standard and proposed designs must accompany all submittals demonstrating compliance under the simulated performance alternative.

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405.5.2 – RESIDENCE SPECIFICATIONS

Table 405.5.2(1) - Specifications for the Standard Reference and Proposed Designs

- Building Component
- Standard Reference Design
- Proposed Design

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TABLE 405.5.2(1)
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Above-grade walls	Type: mass wall if proposed wall is mass; otherwise wood frame Gross area: same as proposed *U*-factor: from Table 402.1.3 Solar absorptance = 0.75 Remittance = 0.90	As proposed As proposed As proposed As proposed As proposed
Basement and crawl space walls	Type: same as proposed Gross area: same as proposed *U*-factor: from Table 402.1.3, with insulation layer on interior side of walls.	As proposed As proposed As proposed
Above-grade floors	Type: wood frame Gross area: same as proposed *U*-factor: from Table 402.1.3	As proposed As proposed As proposed
Ceilings	Type: wood frame Gross area: same as proposed *U*-factor: from Table 402.1.3	As proposed As proposed As proposed
Roofs	Type: composition shingle on wood sheathing Gross area: same as proposed Solar absorptance = 0.75 Emittance = 0.90	As proposed As proposed As proposed As proposed
Attics	Type: vented with aperture = 1 ft^2 per 300 ft^2 ceiling area	As proposed
Foundations	Type: same as proposed foundation wall area above and below grade and soil characteristics: same as proposed.	As proposed As proposed
Doors	Area: 40 ft^2 Orientation: North *U*-factor: same as fenestration from Table 402.1.3	As proposed As proposed As proposed
Glazing[a]	Total area[b] = (a) The proposed glazing area; where proposed glazing area is less than 15% of the conditioned floor area. (b) 15% of the conditioned floor area; where the proposed glazing area is 15% or more of the conditioned floor area. Orientation: equally distributed to four cardinal compass orientations (N, E, S & W). *U*-factor: from Table 402.1.3 SHGC: From Table 402.1.1 except that for climates with no requirement (NR) SHGC = 0.40 shall be used. Interior shade fraction: Summer (all hours when cooling is required) = 0.70 Winter (all hours when heating is required) = 0.85[c] External shading: none	As proposed As proposed As proposed As proposed Same as standard reference design As proposed
Skylights	None	As proposed
Thermally isolated sunrooms	None	As proposed

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TABLE 405.5.2(1)—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	Specific leakage area (SLA)[d] = 0.00036 assuming no energy recovery	For residences that are not tested, the same as the standard reference design. For residences without mechanical ventilation that are tested in accordance with ASHRAE 119, Section 5.1, the measured air exchange rate[e] but not less than 0.35 ACH For residences with mechanical ventilation that are tested in accordance with ASHRAE 119, Section 5.1, the measured air exchange rate[e] combined with the mechanical ventilation rate,[f] which shall not be less than $0.01 \times CFA + 7.5 \times (N_{br}+1)$ where: *CFA* = conditioned floor area N_{br} = number of bedrooms
Mechanical ventilation	None, except where mechanical ventilation is specified by the proposed design, in which case: Annual vent fan energy use: $kWh/yr = 0.03942 \times CFA + 29.565 \times (N_{br}+1)$ where: *CFA* = conditioned floor area N_{br} = number of bedrooms	As proposed
Internal gains	$IGain = 17{,}900 + 23.8 \times CFA + 4104 \times N_{br}$ (Btu/day per dwelling unit)	Same as standard reference design
Internal mass	An internal mass for furniture and contents of 8 pounds per square foot of floor area	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element[g] but not integral to the building envelope or structure
Structural mass	For masonry floor slabs, 80% of floor area covered by R-2 carpet and pad, and 20% of floor directly exposed to room air. For masonry basement walls, as proposed, but with insulation required by Table 402.1.3 located on the interior side of the walls For other walls, for ceilings, floors, and interior walls, wood frame construction	As proposed As proposed As proposed
Heating systems[h,i]	As proposed Capacity: sized in accordance with Section M1401.3 of the *International Residential Code*	As proposed
Cooling systems[h,j]	As proposed Capacity: sized in accordance with Section M1401.3 of the *International Residential Code*	As proposed
Service water heating[h,k,l]	As proposed Use: same as proposed design	As proposed $gal/day = 30 + (10 \times N_{br})$
Thermal distribution systems	A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. Duct insulation: From Section 403.2.1. For tested duct systems, the leakage rate shall be the applicable maximum rate from Section 403.2.2.	As tested or as specified in Table 405.5.2(2) if not tested
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference

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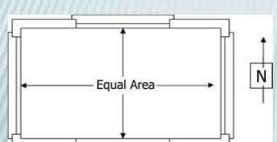
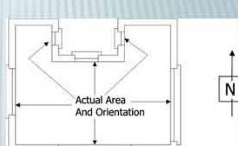
TABLE 405.5.2(1) – GLAZING





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DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES

Proposed Design

TABLE 405.5.2(2)
DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS[a]

DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION:	FORCED AIR SYSTEMS	HYDRONIC SYSTEMS[b]
Distribution system components located in unconditioned space	—	0.95
Untested distribution systems entirely located in conditioned space[c]	0.88	1
"Ductless" systems[d]	1	—

For SI: 1 cubic foot per minute = 0.47 L/s; 1 square foot = 0.093 m^2; 1 pound per square inch = 6895 Pa; 1 inch water gauge = 1250 Pa.
a. Default values given by this table are for untested distribution systems, which must still meet minimum requirements for duct system insulation.
b. Hydronic systems shall mean those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed loop piping and that do not depend on ducted, forced airflow to maintain space temperatures.
c. Entire system in conditioned space shall mean that no component of the distribution system, including the air handler unit, is located outside of the conditioned space.
d. Ductless systems shall be allowed to have forced airflow across a coil but shall not have any ducted airflow external to the manufacturer's air handler enclosure.

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THANKS FOR THE SUPPORT OF THE
State Energy Conservation Office (SECO)
especially Felix Lopez
SECO
State Energy Conservation Office


QUESTIONS AND ANSWERS
Q&A

3.9 Evaluation of Additional Technologies for Reducing Energy Use in Existing Buildings

The Laboratory provided technical assistance to the TCEQ, the PUCT, SECO and ERCOT, as well as Stakeholders participating in the Energy Code and Renewables programs.

- In 2008, the Laboratory continued to work with the TCEQ to develop an integrated NOx emissions reductions calculation that provided the TCEQ with a creditable NOx emissions reductions from energy efficiency and renewable energy (EE/RE) programs reported to the TCEQ in 2008 by the Laboratory, PUCT, SECO, and ERCOT (i.e., wind).
- At the request of the TCEQ, the Laboratory has continued the development of procedures for quantifying NOx emissions reductions from wind turbines that includes weather normalization and the quantification of NOx emissions reductions from the new Federal regulations for SEER 13 air conditioners.

3.10 Planned Focus for 2010

In FY 2009, the Energy Systems Laboratory will continue in its cooperative efforts with the TCEQ, PUCT, SECO, US EPA and others to ensure EE/RE measures remain a cost-effective solution to clean air, and continue to support the energy efficiency and renewable energy opportunities of the TERP. The Laboratory team will:

- Assist the TCEQ to obtain SIP credits from energy efficiency and renewable energy using the Laboratory's Emissions Reduction Calculator technology;
- Verify, document and report energy efficiency and renewable energy savings in all TERP EE/RE programs for the SIP in each non-attainment and affected county using the TCEQ/US EPA approved technology;
- Assist the PUCT with determining emissions reductions credits from energy efficiency programs funded by SB 7 and SB 5;
- Assist political subdivisions and Councils of Governments with calculating emissions reductions from local code changes and voluntary EE/RE programs for SIP inclusion;
- Continue to refine the cost-effective techniques to implement 15% above code (2009 IECC) energy efficiency in low-priced and moderately-priced residential housing;
- Continue to refine the cost-effective methods and techniques to implement 15% above code energy efficiency in low-priced and moderately-priced commercial buildings;
- Continue to develop creditable procedures for calculating NOx emissions reductions from green renewable technologies, including wind power, solar energy and geothermal energy systems;
- Continue development of well-documented, integrated NOx emissions reductions methodologies for calculating and reporting NOx reductions, including a unified database framework for required reporting to TCEQ of potentially creditable measures from the ESL, PUCT, and SECO SB 5 initiatives;
- Upon request, provide written recommendations to the State Energy Conservation Office (SECO) about whether or not the energy efficiency provisions of latest published edition of the International Residential Code (IRC), or the International Energy Conservation Code (IECC), are equivalent to, or better than, the energy efficiency and air quality achievable under the editions adopted under the 2001 IRC/IECC. This will consider comments made by persons who have an interest in the adoption of the energy codes in the recommendations made to SECO.
- Develop a standardized report format to be used by providers of home energy ratings, including different report formats for rating newly constructed residences from those for existing residences.
- Continue to cooperate with an industry organization or trade association to: develop guidelines for home energy ratings; provide training for individuals performing home energy ratings and providers of home energy ratings; and provide a registry of completed ratings for newly constructed residences and residential improvement projects for the purpose of computing the energy savings and emissions reductions benefits of the home energy ratings program.
- Include all benefits attained from this program in an annual report to the commission.

- Enhance IC3 to support multifamily residences, and add other features to enhance adoption.
- Engage production builders and municipalities in overcoming obstacles to their using IC3 for their new home construction.
- Seek funding to enhance TCV (Austin's version of Ice).
- Replace ESL and TERP (SB5) websites with more accessible, easily navigable sites.

The Laboratory has and will continue to provide leading-edge technical assistance to counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering emissions and improving the air for all Texans. The Laboratory will continue to provide superior technology to the State of Texas through efforts with the TCEQ and US EPA. The efforts taken by the Laboratory have produced significant success in bringing EE/RE closer to US EPA acceptance in the SIP.

4 Introduction

4.1 Background

In 2001, the Texas Legislature adopted the Texas Emissions Reduction Plan, identifying thirty-eight counties in Texas where a focus on air quality improvements was deemed critical to public health and economic growth. These areas are shown on the map in Figure 8 as non-attainment and near nonattainment. In 2008, the twenty counties designated as nonattainment counties include: Brazoria, Chambers, Collin, Dallas, Denton, Ellis, Fort Bend, Hardin, Harris, Jefferson, Galveston, Johnson, Kaufman, Liberty, Montgomery, Orange, Parker, Rockwall, Tarrant, and Waller Counties. The fourteen counties designated as Ozone Early Action Compact counties include: Bastrop, Bexar, Caldwell, Comal, Gregg, Guadalupe, Harrison, Hays, Rusk, Smith, Travis, Upshur, Williamson, and Wilson County.

These counties represent several geographic areas of the state, which have been assigned to different climate zones by the 2001 IECC[12] as shown in Figure 9, based primarily on Heating Degree Days (HDD). These include climate zone 5 or 6 (i.e., 2,000 to 2,999 HDD_{65}) for the Dallas-Ft. Worth and El Paso areas, and climate zones 3 and 4 (i.e., 1,000 to 1,999 HDD_{65}) for the Houston-Galveston-Beaumont-Port Arthur-Brazoria areas. Also shown in Figure 9 are the locations of the various weather data sources, including the Typical Meteorological Year (TMY2) (NREL 1995) stations, the Weather Year for Energy Calculations (WYEC2) (Stoffel 1995) weather stations, the National Weather Service weather stations, (NWS) (NOAA 1993) weather stations, the ASHRAE 90.1 1989 weather locations[13], the ASHRAE 90.1 1999 weather locations, the solar stations measured by the National Renewable Energy Laboratory (NREL)[14], the solar stations measured by the TCEQ[15], and F-CHART and PV F-CHART weather locations[16].

[12] The "2000 IECC" notation is used to signify the 2000 International Residential Code (IRC), which includes the International Energy Conservation Code (IECC) as modified by the 2001 Supplement (IECC 2001), published by the ICC in March of 2001, as required by Senate Bill 5.

[13] The ASHRAE 90.1-1989 and 90.1-1999 weather stations are used in the emissions calculator for determining the building characteristics.

[14] The NREL stations were the primary source of the 1999 global horizontal, direct normal and diffuse solar radiation used to determine the 1999 peak-day and annual emissions for the DOE-2 simulations for code-compliant housing and commercial buildings.

[15] The TCEQ stations were used as the secondary source for global horizontal solar radiation when the NREL sites were missing data or no NREL site was nearby.

[16] The F-Chart and PV F-Chart weather locations are used to determine the solar thermal or electricity produced by the systems specified by the use in the emissions calculation. The monthly energy or electricity production from F-Chart or PV F-Chart is then weather-normalized using ASHRAE's Inverse Model Toolkit to develop coefficients that are then used to determine the 1999 annual and peak day energy or electricity production for emissions calculations.

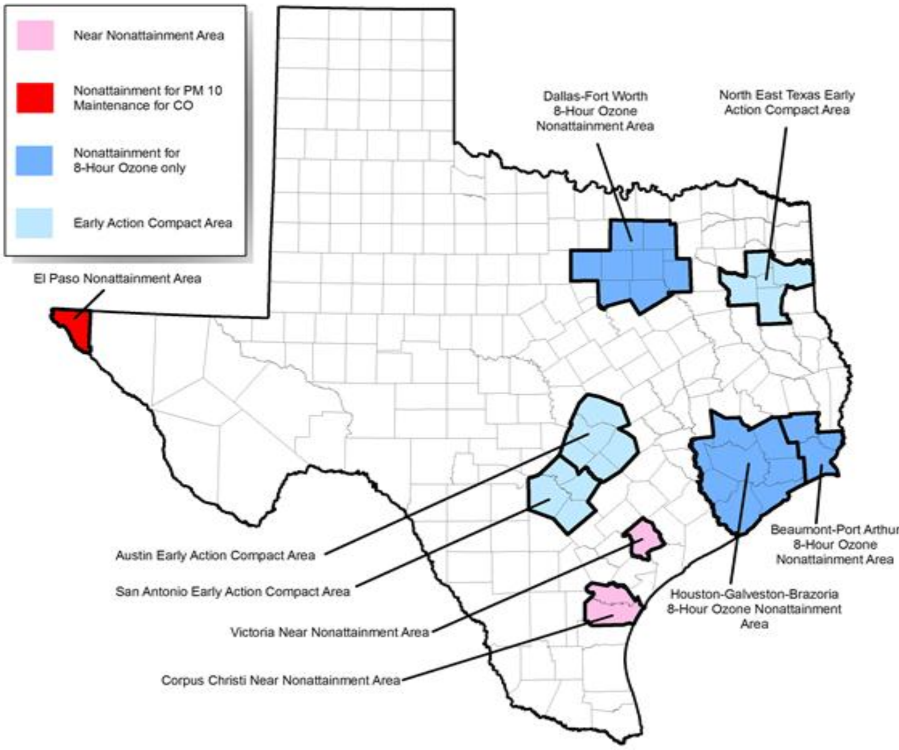


Figure 8: US EPA Nonattainment and Near Nonattainment

4.2 Energy Systems Laboratory's Responsibilities in the TERP

In 2001, Texas Senate Bill 5 outlined the following responsibilities for the Energy Systems Laboratory (ESL) within the TERP:

- Sec. 386.205. Evaluation of State Energy Efficiency Programs.
- Sec. 388.003. Adoption of Building Energy Efficiency Performance Standards.
- Sec. 388.004. Enforcement of Energy Standards Outside of Municipality.
- Sec. 388.007. Distribution of Information and Technical Assistance.
- Sec. 388.008. Development of Home Energy Ratings.

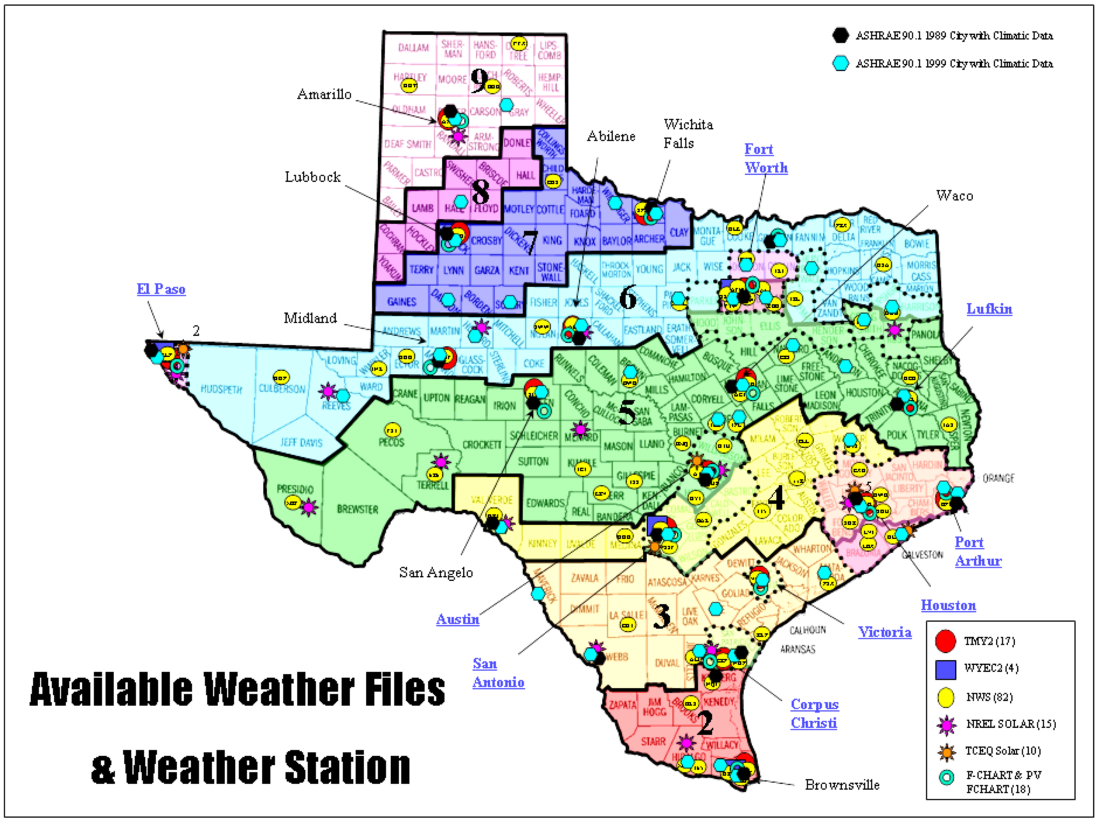
These responsibilities were updated in 2003:

1) with House Bill 1365, including modifications to:

- Sec. 388.004. Enforcement of Energy Standards Outside of Municipality.
- Sec. 388.009. Energy-Efficient Building Program.

2) with House Bill 3235, including modifications to:

- Sec. 388.009. Certification of Municipal Building Inspectors.



List of Available Weather Files and Weather Stations of Texas

Texas Weather Stations (NOAA)

1 Abilene Regional Airport (ABI)
2 Alice International Airport (ALI)
3 Amarillo International Airport (AMA)
4 Angleton / Lake Jackson Brazori (LBX)
5 Arlington Municipal Airport (GKY)
6 Austin - Bergstrom International (AUS)
7 Austin Camp Mabry (ATT)
8 Borger Hutchinson County Airport (BGD)
9 BRENHAM: BRENHAM MUNICIPAL AIRPORT (11R)
10 Brownsville S Padre Isl International (BRO)
11 BROWNWOOD: BROWNWOOD REGIONAL AIRPORT (BWD)
12 Burnet Municipal Airport (BMQ)
13 Childress Municipal Airport (CDS)
14 College Station (CLL)
15 Conroe Montgomery County Airport (CXO)
16 Corpus Christi International Airport (CRP)
17 CORPUS CHRISTI: CORPUS CHRISTI NAS/TRUAX FIELD ARPT (NGP)
18 Corsicana Campbell Field (CRS)
19 Cotulla La Salle Co Airport (COT)
20 Dalhart Municipal Airport (DHT)
21 Dallas - Fort Worth International Airport (DFW)
22 Dallas Love Field (DAL)
23 Dallas Redbird Airport (RBD)
24 Del Rio International Airport (DRT)
25 Denton Municipal Airport (DTO)
26 Dryden Terrell County Airport (6R6)
27 El Paso International Airport (ELP)
28 FALFURRIAS: BROOKS COUNTY AIRPORT (BKS)
29 Fort Stockton Pecos County Airport (FST)
30 Fort Worth Alliance Airport (AFW)
31 Fort Worth Meacham (FTW)
32 FREDERICKSBURG: GILLESPIE COUNTY AIRPORT (T82)
33 GAINESVILLE: GAINESVILLE MUNICIPAL AIRPORT (GLE)
34 Galveston Scholes Field (GLS)
35 GEORGETOWN: GEORGETOWN MUNICIPAL AIRPORT (GTU)
36 Harlingen Rio Grande Valley I (HRL)
37 Hondo Municipal Airport (HDO)
38 Houston Bush Intercontinental (IAH)
39 Houston Clover Field (LVJ)
40 Houston Hooks Memorial Airport (DWH)
41 Houston Sugarland Mem (SGR)
42 Houston William P Hobby Airport (HOU)
43 Huntsville Municipal Airport (UTS)
44 JASPER: JASPER COUNTY-BELL FIELD AIRPORT (JAS)
45 Junction Kimble County Airport (JCT)
46 KERRVILLE: KERRVILLE MUNI/LOUIS SCHREINER FLD AIRPORT (ERV)
47 KILLEEN: KILLEEN MUNICIPAL AIRPORT (ILE)
48 KINGSVILLE: KINGSVILLE NAS AIRPORT (NQI)
49 LA GRANGE: FAYETTE REGIONAL AIR CENTER AIRPORT (3T5)
50 Longview E Tx Rgnl Airport (GGG)
51 Lubbock International Airport (LBB)
52 Lufkin Angelina Cty Airport (LFK)
53 MARFA: MARFA MUNICIPAL AIRPORT (MRF)
54 McAllen Miller International Airport (MFE)
55 McKinney Municipal Airport (TKI)
56 Midland International Airport (MAF)
57 Mineral Wells Airport (MWL)
58 MOUNT PLEASANT: MOUNT PLEASANT REGIONAL AIRPORT (OSA)
59 NACOGDOCHES: A L MANGHAM JR REGIONAL AIRPORT (OCH)
60 New Braunfels Municipal Airport (BAZ)
61 Odessa Schlemeyer Field (ODO)
62 Palacios Municipal Airport (PSX)
63 PARIS: COX FIELD AIRPORT (PRX)
64 PERRYTON: PERRYTON OCHILTREE COUNTY AIRPORT (PYX)
65 Pine Springs Guadalupe Mountn (GDP)
66 Port Arthur Se Tx Rgnl Airport (BPT)
67 Port Isabel Cameron County Airport (PIL)
68 Rockport Aransas Co Airport (RKP)
69 San Angelo Mathis Field (SJT)
70 San Antonio International Airport (SAT)
71 San Antonio Stinson Municipal Airport (SSF)
72 SAN MARCOS: SAN MARCOS MUNICIPAL AIRPORT (HYI)
73 SWEETWATER: AVENGER FIELD AIRPORT (SWW)
74 TEMPLE: DRAUGHON-MILLER CNTRL TEXAS REGIONAL ARPT (TPL)
75 Terrell Municipal Airport (TRL)
76 Tyler Pounds Field (TYR)
77 Victoria Regional Airport (VCT)
78 WACO: MC GREGOR EXECUTIVE AIRPORT (PWG)
79 Waco Regional Airport (ACT)
80 WESLACO: MID VALLEY AIRPORT (T65)
81 Wichita Falls Municipal Airport (SPS)
82 Wink Winkler Co Airport (INK)

Texas TMY2 Weather Files

1 Abilene
2 Amarillo
3 Austin
4 Brownsville
5 Corpus Christi
6 El Paso
7 Fort Worth
8 Houston
9 Lubbock
10 Lufkin
11 Midland
12 Port Arthur
13 San Angelo
14 San Antonio
15 Victoria
16 Waco
17 Wichita Falls

Texas WYEC2 Weather Files

1 El Paso
2 Brownsville
3 Fort Worth
4 San Antonio

NREL Solar Stations

1 Abilene
2 Austin
3 Big Spring
4 Canyon
5 Clear Lake
6 Corpus Christi
7 Del Rio
8 Edinburg
9 El Paso
10 Laredo
11 Menard
12 Overton
13 Pecos
14 Presidio
15 Sanderson

TCEQ Solar Stations

1 Bexar
2 Travis
3 El Paso (2)
4 Galveston
5 Harris (5)

FCHART and PV FCHART (New Weather File)

1 ABILENE
2 AMARILLO
3 AUSTIN
4 BROWNSVILLE
5 CORPUS CHRISTI
6 EL PASO
7 FORT WORTH
8 HOUSTON
9 LUBBOCK
10 LUFKIN
11 MIDLAND-ODESSA
12 PORT ARTHUR
13 SAN ANGELO
14 SAN ANTONIO
15 SHERMAN
16 VICTORIA
17 WACO
18 WICHITA FALLS

Figure 9: Available NWS, TMY2 and WYEC2 weather files compared to IECC/IRC weather zones for Texas

These same responsibilities were further updated in 2005:

- with Senate Bill 20, House Bill 2481, and 2129.

These responsibilities were further updated in 2007:

- with Senate Bill 12 and House Bill 3693.

These responsibilities were further updated in 2007:

- with Senate Bill 12 and House Bill 3693.

In the following sections each of these tasks is further described.

4.2.1 (SB 5) Section 386.205. Evaluation of State Energy Efficiency Programs (w/PUCT)

The Laboratory is instructed to assist the Public Utility Commission of Texas (PUCT) and provide an annual report that quantifies by county the reductions of energy demand, peak loads, and associated emissions of air contaminants achieved from the programs implemented under this subchapter and from those implemented under Section 39.905, Utilities Code (i.e., Senate Bill 7).(SB 5) Sec. 388.003. Adoption of Building Energy Efficiency Performance Standards.

TERP adopts the energy efficiency chapter of the 2001 International Residential Code (2001 IRC) as an energy code for single-family residential construction, and the 2001 International Energy Conservation Code (2001 IECC) for all other residential, commercial and industrial construction in the state. It requires that municipalities establish procedures for administration and enforcement, and ensure that code-certified inspectors perform inspections.

TERP provides that local amendments, in non-attainment areas and affected counties, may not result in less stringent energy efficiency requirements. The Laboratory is to review local amendments, if requested, and submit an annual report of savings impacts to the TCEQ. The Laboratory is also authorized to collect fees for certain of its tasks in Sections 388.004, 388.007 and 388.008.

4.2.3 (SB 5) Sec. 388.004. Enforcement of Energy Standards Outside of Municipality

For construction outside of the local jurisdiction of a municipality, TERP provides for a building to comply if:

a) a building certified by a national, state, or local accredited energy efficiency program shall be considered in compliance;
b) a building with inspections from private code-certified inspectors using the energy efficiency chapter of the International Residential Code or International Energy Conservation Code shall be considered in compliance; and
c) a builder who does not have access to either of the above methods for a building shall certify compliance using a form provided by the Laboratory, enumerating the code-compliance features of the building.

4.2.4 (SB 5) Sec. 388.007. Distribution of Information and Technical Assistance

The Laboratory is required to make available to builders, designers, engineers, and architects code implementation materials that explain the requirements of the International Energy Conservation Code and the energy efficiency chapter of the International Residential Code. TERP authorizes the Laboratory to develop simplified materials to be designed for projects in which a design professional is not involved. It also authorizes the Laboratory to provide local jurisdictions with technical assistance concerning implementation and enforcement of the International Energy Conservation Code and the energy efficiency chapter of the International Residential Code.(SB 5) Sec. 388.008. Development of Home Energy Ratings.

TERP requires the Laboratory to develop a standardized report format to be used by providers of home energy ratings (HERs). The form must be designed to give potential buyers information on a structure's energy performance, including certain equipment. TERP requires the Laboratory to establish a public information program to inform homeowners, sellers, buyers, and others regarding home energy ratings.

4.2.6 (HB 1365) Sec. 388.004. Enforcement of Energy Standards Outside of Municipality

In 2003, House Bill 1365 modified Section 388.004 of The TERP to include the following new requirements:

- That builders shall retain for three years documentation which shows their building is in compliance with the Texas Building Energy Performance Standards, and that builders shall provide a copy of the compliance documentation to homeowners.
- That single-family residences built in unincorporated areas of counties, which were completed on or after September 1, 2001, but not later than August 31, 2003, are considered in compliance with the Texas Building Energy Performance Standards.

To help builders comply with these requirements, the Laboratory will enhance the current form, which is posted on the Laboratory’s The TERP website.

4.2.7 (HB 1365) Sec. 388.009. Energy-Efficient Building Program

In 2003, House Bill 1365 modified the TERP, adding a new Section 388.009. In this section the General Land Office, the TCEQ and the Laboratory, working with an advisory committee, may develop an energy-efficient building accreditation program for buildings that exceed the building energy performance standards under Section 388.003 by 15% or more. This program shall be updated annually to include best available energy-efficient building practices. This program shall use a checklist system to produce an energy-efficient building scorecard to help: (1) home buyers compare potential homes and, by providing a copy of the completed scorecard to a mortgage lender, qualify for energy-efficient mortgages under the National Housing Act; and (2) communities qualify for emissions reduction credits by adopting codes that meet or exceed the energy-efficient building or energy performance standards established under this chapter. This effort may include a public information program to inform homeowners, sellers, buyers, and others regarding energy-efficient building ratings. The Laboratory shall establish a system to measure the reduction in energy and emissions produced under the energy-efficient building program and report those savings to the commission.

4.2.8 (HB 3235) Sec. 388.009. Certification of Municipal Inspectors

Also in 2003, House Bill 3235 modified the TERP to add the new Section 388.009. In this section the Laboratory is required to develop and administer a state-wide training program for municipal building inspectors who seek to become code-certified inspectors. To accomplish this, the Laboratory will work with national code organizations to assist participants in the certification program and is allowed to collect a reasonable fee from participants in the program to pay for the costs of administering the program. This program is required to be developed no later than January 1, 2004, with state-wide training sessions starting no later than March 1, 2004.

4.2.9 (SB 20, HB 2481, HB 2129). Additional Energy-Efficiency Initiatives

The 79th Legislature, through SB 20, HB 2481 and HB 2129, amended SB 5 to enhance its effectiveness by adding the following additional energy-efficiency initiatives, including requiring 5,880 MW of generating capacity from renewable energy technologies by 2015, and 500 MW from non-wind renewables.

This legislation also requires PUCT to establish a target of 10,000 MW of installed renewable capacity by 2025, and requires TCEQ to develop a methodology for computing emissions reductions from renewable energy initiatives and the associated credits. The Laboratory is to assist TCEQ in quantifying emissions reductions credits from energy-efficiency and renewable-energy programs, through a contract with the Texas Environmental Research Consortium (TERC) to develop and annually calculate creditable emissions reductions from wind and other renewable energy resources for the state's SIP.

Finally, this legislation requires the Laboratory to develop at least 3 alternative methods for achieving a 15% greater potential energy savings in residential, commercial and industrial construction. To accomplish this, the Laboratory will be using the code-compliance calculator to ascertain which measures are best suited for reducing energy use without requiring substantial investments.

4.2.10 (SB 12, HB 3693). Additional Energy-Efficiency Initiatives

The 80th Legislature (2007), through SB 12, and HB 3693 amended SB 5 to enhance its effectiveness by adding several new energy efficiency initiatives. First, it requires the Laboratory to provide written recommendations to the State Energy Conservation Office (SECO) about whether or not the energy efficiency provisions of latest published edition of the International Residential Code (IRC), or the International Energy Conservation Code (IECC), are equivalent to or better than the energy efficiency and air quality achievable under the editions adopted under the 2001 IRC/IECC. The laboratory shall make its recommendations not later than six months after publication of new editions at the end of each three-year code development cycle of the International Residential Code and the International Energy Conservation Code. As part of this work with SECO, the Laboratory is required to consider comments made by persons who have an interest in the adoption of the energy codes in the recommendations made to SECO.

In addition, it requires the Laboratory to develop a standardized report format to be used by providers of home energy ratings, including different report formats for rating newly constructed residences from those for existing residences. The form must be designed to give potential buyers information on a structure's energy performance, including: insulation; types of windows; heating and cooling equipment; water heating equipment; additional energy conserving features, if any; results of performance measurements of building tightness and forced air distribution; and an overall rating of probable energy efficiency relative to the minimum requirements of the International Energy Conservation Code or the energy efficiency chapter of the International Residential Code, as appropriate.

It also encourages the Laboratory to cooperate with an industry organization or trade association to: develop guidelines for home energy ratings; provide training for individuals performing home energy ratings and providers of home energy ratings; and provide a registry of completed ratings for newly constructed residences and residential improvement projects for the purpose of computing the energy savings and emissions reductions benefits of the home energy ratings program. Finally, it requires the Laboratory shall to include information on the benefits attained from this program in an annual report to the commission.

5 Progress: January 2009 through December 2009

5.1 (SB 5) Section 386.205. Evaluation of State Energy-Efficiency Programs (w/PUCT)

5.1.1 Implemented Procedures for Evaluating State Energy-Efficiency Programs

In 2004 the Laboratory held several meetings with the Public Utility Commission of Texas to discuss the development of a framework for reporting emissions reduction from the State Energy Efficiency Programs administered by the PUCT. The State Energy-Efficiency Programs administered by the PUCT include programs under Senate Bill 7 (i.e., Section 39.905 Utilities Code) and Senate Bill 5.

In 2003 and 2004, the Laboratory worked with the TCEQ to identify a method to help the PUCT more accurately report their deemed savings as peak-day savings in 1999, using the Laboratory's new emissions reductions calculator. In 2005, this method was implemented in the TCEQ's Integrated Emissions Calculations, which was reported in the 2005, 2006, 2007, 2008 and 2009 annual report.

5.2 (SB 5) Sec. 388.003. Adoption of Building Energy-Efficiency Performance Standards

5.2.1 Provide Code Training Sessions

During the 77th Legislature, Senate Bill 5 (SB 5) adopted the 2000 International Residential Code (IRC) as the energy code for single-family residential construction and the 2000 edition of the International Energy Conservation Code (IECC), with the 2001 Supplement for all other residential, commercial and industrial construction in the state. It requires that municipalities establish procedures for administration and enforcement, and ensure that code-certified inspectors perform inspections.

These codes are published by the International Code Council (ICC), which publishes a new edition every three years and a supplement in the intervening years. The 2003 Codes have been reviewed and determined to be no less stringent than the editions currently adopted by SB 5. Transition to the 2003 IRC and IECC can be easily accomplished. The 2006 Codes were reviewed and the residential provisions were determined to be less stringent than the editions adopted by SB 5 while the commercial provisions were determined to be as stringent as those in SB 5. Energy System Laboratory has assisted the local legislative bodies with amendments to the residential portions of the 2006 International Energy Conservation Code to insure it remains in compliance with the State Regulations concerning stringency.

Section 388.009 requires the Laboratory to develop and administer a state-wide training program for municipal building inspectors who seek to become code-certified inspectors. To accomplish this, the Laboratory developed the Energy Code Workshops which are based on the 2003 and 2006 International Energy Conservation Code (IECC) as published by the International Code Council (ICC) for residential and commercial buildings, with amendments. In addition, three more workshops were developed that offered software training, ASHRAE Standard 62.1 and ASHRAE Standard 90.1.

The Residential Energy Code Training Workshop and Commercial Requirements of the International Energy Conservation Workshop both include an overview of the TERP program and extensive instruction on all chapters of the IECC, which include the general requirements, definitions, and design conditions. The 2003 and 2006 Residential Workshops also includes detailed instruction on Chapter(s) which contain specific regulations relating to residential construction, in addition to a comparison of the IECC and the energy provisions of the International Residential Code (IRC). The 2003 and 2006 Commercial Workshops includes detailed instruction on Chapter(s), which relate to commercial regulations and a summary of the relationship between ASHRAE 90.1 and the commercial provisions of the IECC.

In 2009 the TERP group prepared for the trainings that were to be offered in 2010.

- January 23-27: Gathering of 90.1 updated materials from the ASHRAE 90.1 Standards committee meetings in Orlando, Florida. These were organized into workshop presentation materials for workshops offered in 2010.
- June 26-30: Participation in the ASHRAE 90.1 Standards committee meetings in Albuquerque, New Mexico, to obtain critical updates for the offering of 90.1 training workshops, which came later in 2010.

5.2.2 Summary of ASHRAE Standard 90.1 Standards Committee Activities during 2009, and Ongoing Subcommittee Actions

The following paragraphs summarize discussions at the ASHRAE Standards Committee meetings at Chicago, IL in January 2009 and Louisville, KY in June 2009 and the subcommittee actions. This update is divided into four subsections. Each subsection presents notes from discussions and addenda proposed by the envelope, mechanical, lighting and ECB subcommittees.

5.2.2.1 From the Envelope Subcommittee

Two items were proposed as addenda to the 2007 version of the ASHRAE 90.1 code. Addendum g updates the building envelope criteria for metal buildings. Addendum q modifies the vestibule requirements for climate zone 4.

Addenda:

Addendum g: This addendum updates the building envelope criteria for metal buildings for the first time since Standard 90.1-1999. Other envelope criteria were updated through addenda as and at to Standard 90.1-2004.

TABLE 5.5-1 Building Envelope Requirements For Climate Zone 1 (A, B)*

Opaque Elements	Nonresidential Assembly Maximum	Nonresidential Insulation Min. R-Value	Residential Assembly Maximum	Residential Insulation Min. R-Value	Semiheated Assembly Maximum	Semiheated Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.063	R-15.0 c.i.	U-0.048	R-20.0 c.i.	U-0.218	R-3.8 ci
Metal Building[a]	U-0.065	R-19.0	U-0.065	R-19.0	~~U-1.280~~ U-0.167	~~NR~~ R-6.0
Attic and Other	U-0.034	R-30.0	U-0.027	R-38.0	U-0.081	R-13.0
Walls, Above-Grade						
Mass	U-0.580	NR	U-0.151[~~a~~b]	R-5.7 c.i.[~~a~~b]	U-0.580	NR
Metal Building	~~U-0.113~~ U-0.093	~~R-13.0~~ R-16.0	~~U-0.113~~ U-0.093	~~R-13.0~~ R-16.0	~~U-1.180~~ U-0.113	~~NR~~ R-13.0
Steel-Framed	U-0.124	R-13.0	U-0.124	R-13.0	U-0.352	NR
Wood-Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.292	NR
Walls, Below-Grade						
Below-Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.322	NR	U-0.322	NR	U-0.322	NR
Steel-Joist	U-0.350	NR	U-0.350	NR	U-0.350	NR
Wood-Framed and Other	U-0.282	NR	U-0.282	NR	U-0.282	NR
Slab-On-Grade Floors						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.450		U-1.450		U-1.450	
Fenestration	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**
Vertical Glazing, 0%–40% of Wall						
Nonmetal framing (all)[~~b~~c]	U-1.20	SHGC-0.25 all	U-1.20	SHGC-0.25 all	U-1.20	SHGC-NR all
Metal framing (curtainwall/storefront)[~~c~~d]	U-1.20		U-1.20		U-1.20	
Metal framing (entrance door)[~~c~~d]	U-1.20		U-1.20		U-1.20	
Metal framing (all other)[~~c~~d]	U-1.20		U-1.20		U-1.20	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}–1.98	$SHGC_{all}$–0.36	U_{all}–1.98	$SHGC_{all}$–0.19	U_{all}–1.98	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.98	$SHGC_{all}$–0.19	U_{all}–1.98	$SHGC_{all}$–0.16	U_{all}–1.98	$SHGC_{all}$–NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}–1.90	$SHGC_{all}$–0.34	U_{all}–1.90	$SHGC_{all}$–0.27	U_{all}–1.90	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.90	$SHGC_{all}$–0.27	U_{all}–1.90	$SHGC_{all}$–0.27	U_{all}–1.90	$SHGC_{all}$–NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}–1.36	$SHGC_{all}$–0.36	U_{all}–1.36	$SHGC_{all}$–0.19	U_{all}–1.36	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.36	$SHGC_{all}$–0.19	U_{all}–1.36	$SHGC_{all}$–0.19	U_{all}–1.36	$SHGC_{all}$–NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.
[a] When using R-value compliance method, a thermal spacer block is required; otherwise use the U-factor compliance method. See Table A2.3.
[~~a~~b] Exception to Section A3.1.3.1 applies.
[~~b~~c] Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
[~~c~~d] Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Figure 10: Building Envelope Requirements for Climate Zone 1

TABLE 5.5-2 Building Envelope Requirements For Climate Zone 2 (A, B)*

Opaque Elements	Nonresidential Assembly Maximum	Nonresidential Insulation Min. R-Value	Residential Assembly Maximum	Residential Insulation Min. R-Value	Semiheated Assembly Maximum	Semiheated Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.218	R-3.8 c.i.
Metal Building[a]	~~U-0.065~~ U-0.055	~~R-19.0~~ R-13.0 + R-13.0	~~U-0.065~~ U-0.055	~~R-19.0~~ R-13.0 + R-13.0	~~U-0.167~~ U-0.097	~~R-6.0~~ R-10.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.081	R-13.0
Walls, Above-Grade						
Mass	U-0.151[ab]	R5.7 c.i.[ab]	U-0.123	R-7.6 c.i.	U-0.580	NR
Metal Building	~~U-0.113~~ U-0.093	~~R-13.0~~ R-16.0	~~U-0.113~~ U-0.093	~~R-13.0~~ R-16.0	~~U-0.184~~ U-0.113	~~R-6.0~~ R-13.0
Steel-Framed	U-0.124	R-13.0	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.107	R-6.3 c.i.	U-0.087	R-8.3 c.i.	U-0.322	NR
Steel-Joist	U-0.052	R-19.0	U-0.052	R-19.0	U-0.069	R-13.0
Wood-Framed and Other	U-0.051	R-19.0	U-0.033	R-30.0	U-0.066	R-13.0
Slab-On-Grade Floors						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.450		U-0.500		U-1.450	
Fenestration	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**
Vertical Glazing, 0%–40% of Wall						
Nonmetal framing (all)[bc]	U-0.75	SHGC-0.25 all	U-0.75	SHGC-0.25 all	U-1.20	SHGC-NR all
Metal framing (curtainwall/storefront)[cd]	U-0.70		U-0.70		U-1.20	
Metal framing (entrance door)[cd]	U-1.10		U-1.10		U-1.20	
Metal framing (all other)[cd]	U-0.75		U-0.75		U-1.20	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}–1.98	$SHGC_{all}$–0.36	U_{all}–1.98	$SHGC_{all}$–0.19	U_{all}–1.98	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.98	$SHGC_{all}$–0.19	U_{all}–1.98	$SHGC_{all}$–0.19	U_{all}–1.98	$SHGC_{all}$–NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}–1.90	$SHGC_{all}$–0.39	U_{all}–1.90	$SHGC_{all}$–0.27	U_{all}–1.90	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.90	$SHGC_{all}$–0.34	U_{all}–1.90	$SHGC_{all}$–0.27	U_{all}–1.90	$SHGC_{all}$–NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}–1.36	$SHGC_{all}$–0.36	U_{all}–1.36	$SHGC_{all}$–0.19	U_{all}–1.36	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.36	$SHGC_{all}$–0.19	U_{all}–1.36	$SHGC_{all}$–0.19	U_{all}–1.36	$SHGC_{all}$–NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.
[a]When using R-value compliance method, a thermal spacer block is required; otherwise use the U-factor compliance method. See Table A2.3.
[ab]Exception to Section A3.1.3.1 applies.
[bc]Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
[cd]Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Figure 11: Building Envelope Requirements for Climate Zone 2

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TABLE 5.5-3 Building Envelope Requirements For Climate Zone 3 (A, B, C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.173	R-5.0 c.i.
Metal Building[a]	~~U-0.065~~ U-0.055	~~R-19.0~~ R-13.0 + R-13.0	~~U-0.065~~ U-0.055	~~R-19.0~~ R-13.0 + R-13.0	U-0.097	R-10.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.053	R-19.0
Walls, Above-Grade						
Mass	U-0.123	R-7.6 c.i.	U-0.104	R-9.5 c.i.	U-0.580	NR
Metal Building	~~U-0.113~~ U-0.084	~~R-13.0~~ R-19.0	~~U-0.113~~ U-0.084	~~R-13.0~~ R-19.0	~~U-0.184~~ U-0.113	~~R-6.0~~ R-13.0
Steel-Framed	U-0.084	R-13.0 + R-3.8 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.107	R-6.3 c.i.	U-0.087	R-8.3 c.i.	U-0.322	NR
Steel-Joist	U-0.052	R-19.0	U-0.052	R-19.0	U-0.069	R-13.0
Wood-Framed and Other	U-0.051	R-19.0	U-0.033	R-30.0	U-0.066	R-13.0
Slab-On-Grade Floors						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-0.900	R-10 for 24 in.	F-0.900	R-10 for 24 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.450		U-0.500		U-1.450	
Fenestration	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**
Vertical Glazing, 0%–40% of Wall						
Nonmetal framing (all)[b,c]	U-0.65	SHGC-0.25 all	U-0.65	SHGC-0.25 all	U-1.20	SHGC-NR all
Metal framing (curtainwall/storefront)[c,d]	U-0.60		U-0.60		U-1.20	
Metal framing (entrance door)[c,d]	U-0.90		U-0.90		U-1.20	
Metal framing (all other)[c,d]	U-0.65		U-0.65		U-1.20	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}-1.17	$SHGC_{all}$-0.39	U_{all}-1.17	$SHGC_{all}$-0.36	U_{all}-1.98	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-1.17	$SHGC_{all}$-0.19	U_{all}-1.17	$SHGC_{all}$-0.19	U_{all}-1.98	$SHGC_{all}$-NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}-1.30	$SHGC_{all}$-0.65	U_{all}-1.30	$SHGC_{all}$-0.27	U_{all}-1.90	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-1.30	$SHGC_{all}$-0.34	U_{all}-1.30	$SHGC_{all}$-0.27	U_{all}-1.90	$SHGC_{all}$-NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}-0.69	$SHGC_{all}$-0.39	U_{all}-0.69	$SHGC_{all}$-0.36	U_{all}-1.36	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-0.69	$SHGC_{all}$-0.19	U_{all}-0.69	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.
[a]When using R-value compliance method, a thermal spacer block is required; otherwise use the U-factor compliance method. See Table A2.3.
[b]Exception to Section A3.1.3.1 applies.
[c]Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
[d]Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Figure 12: Building Envelope Requirements for Climate Zone 3

TABLE 5.5-4 Building Envelope Requirements For Climate Zone 4 (A, B, C)*

Opaque Elements	Nonresidential Assembly Maximum	Nonresidential Insulation Min. R-Value	Residential Assembly Maximum	Residential Insulation Min. R-Value	Semiheated Assembly Maximum	Semiheated Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.173	R-5.0 c.i.
Metal Building[a]	~~U-0.065~~ U-0.055	~~R-19.0~~ R-13.0 + R-13.0	~~U-0.065~~ U-0.055	~~R-19.0~~ R-13.0 + R-13.0	U-0.097	R-10.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.053	R-19.0
Walls, Above-Grade						
Mass	U-0.104	R-9.5 c.i.	U-0.090	R-11.4 c.i.	U-0.580	NR
Metal Building	~~U-0.113~~ U-0.084	~~R-13.0~~ R-19.0	~~U-0.113~~ U-0.084	~~R-13.0~~ R-19.0	~~U-0.134~~ U-0.113	~~R-10.0~~ R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.089	R-13.0	U-0.064	R-13.0 + R-3.8 c.i.	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-1.140	NR	C-0.119	R-7.5 c.i.	C-1.140	NR
Floors						
Mass	U-0.087	R-8.3 c.i.	U-0.074	R-10.4 c.i.	U-0.137	R-4.2 c.i.
Steel-Joist	U-0.038	R-30.0	U-0.038	R-30.0	U-0.069	R-13.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.066	R-13.0
Slab-On-Grade Floors						
Unheated	F-0.730	NR	F-0.540	R-10 for 24 in.	F-0.730	NR
Heated	F-0.860	R-15 for 24 in.	F-0.860	R-15 for 24in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.500		U-0.500		U-1.450	
Fenestration	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**
Vertical Glazing, 0%–40% of Wall						
Nonmetal framing (all)[~~b~~c]	U-0.40	SHGC-0.40 all	U-0.40	SHGC-0.40 all	U-1.20	SHGC-NR all
Metal framing (curtainwall/storefront)[~~c~~d]	U-0.50		U-0.50		U-1.20	
Metal framing (entrance door)[~~c~~d]	U-0.85		U-0.85		U-1.20	
Metal framing (all other)[~~c~~d]	U-0.55		U-0.55		U-1.20	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}–1.17	$SHGC_{all}$–0.49	U_{all}–0.98	$SHGC_{all}$–0.36	U_{all}–1.98	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.17	$SHGC_{all}$–0.39	U_{all}–0.98	$SHGC_{all}$–0.19	U_{all}–1.98	$SHGC_{all}$–NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}–1.30	$SHGC_{all}$–0.65	U_{all}–1.30	$SHGC_{all}$–0.62	U_{all}–1.90	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.30	$SHGC_{all}$–0.34	U_{all}–1.30	$SHGC_{all}$–0.27	U_{all}–1.90	$SHGC_{all}$–NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}–0.69	$SHGC_{all}$–0.49	U_{all}–0.58	$SHGC_{all}$–0.36	U_{all}–1.36	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–0.69	$SHGC_{all}$–0.39	U_{all}–0.58	$SHGC_{all}$–0.19	U_{all}–1.36	$SHGC_{all}$–NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.
[a]When using R-value compliance method, a thermal spacer block is required; otherwise use the U-factor compliance method. See Table A2.3.
[~~a~~b]Exception to Section A3.1.3.1 applies.
[~~b~~c]Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
[~~c~~d]Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Figure 13: Building Envelope Requirements for Climate Zone 4

TABLE 5.5-5 Building Envelope Requirements For Climate Zone 5 (A, B, C)*

Opaque Elements	Nonresidential Assembly Maximum	Nonresidential Insulation Min. R-Value	Residential Assembly Maximum	Residential Insulation Min. R-Value	Semiheated Assembly Maximum	Semiheated Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.119	R-7.6 c.i.
Metal Building[a]	~~U-0.065~~ U-0.055	~~R-19.0~~ R-13.0 + R-13.0	~~U-0.065~~ U-0.055	~~R-19.0~~ R-13.0 + R-13.0	~~U-0.097~~ U-0.083	~~R-10.0~~ R-13.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.053	R-19.0
Walls, Above-Grade						
Mass	U-0.090	R-11.4 c.i.	U-0.080	R-13.3 c.i.	U-0.151[~~a~~b]	R-5.7 c.i.[~~a~~b]
Metal Building	~~U-0.113~~ U-0.069	~~R-13.0~~ R-13.0 + R- 5.6 c.i.	~~U-0.057~~ U-0.069	~~R-13.0 + R-13.0~~ R-13.0 + R- 5.6 c.i.	~~U-0.123~~ U-0.113	~~R-11.0~~ R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.064	R-13.0 + R-3.8 c.i.	U-0.051	R-13.0 + R-7.5 c.i.	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-0.119	R-7.5 c.i.	C-0.119	R-7.5 c.i.	C-1.140	NR
Floors						
Mass	U-0.074	R-10.4 c.i.	U-0.064	R-12.5 c.i.	U-0.137	R-4.2 c.i.
Steel-Joist	U-0.038	R-30.0	U-0.038	R-30.0	U-0.052	R-19.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.051	R-19.0
Slab-On-Grade Floors						
Unheated	F-0.730	NR	F-0.540	R-10 for 24 in.	F-0.730	NR
Heated	F-0.860	R-15 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	
Fenestration	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**
Vertical Glazing, % of Wall						
Nonmetal framing (all)[~~b~~c]	U-0.35	SHGC-0.40 all	U-0.35	SHGC-0.40 all	U-1.20	SHGC-NR all
Metal framing (curtainwall/storefront)[~~c~~d]	U-0.45		U-0.45		U-1.20	
Metal framing (entrance door)[~~c~~d]	U-0.80		U-0.80		U-1.20	
Metal framing (all other)[~~c~~d]	U-0.55		U-0.55		U-1.20	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}–1.17	$SHGC_{all}$–0.49	U_{all}–1.17	$SHGC_{all}$–0.49	U_{all}–1.98	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.17	$SHGC_{all}$–0.39	U_{all}–1.17	$SHGC_{all}$–0.39	U_{all}–1.98	$SHGC_{all}$–NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}–1.10	$SHGC_{all}$–0.77	U_{all}–1.10	$SHGC_{all}$–0.77	U_{all}–1.90	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.10	$SHGC_{all}$–0.62	U_{all}–1.10	$SHGC_{all}$–0.62	U_{all}–1.90	$SHGC_{all}$–NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}–0.69	$SHGC_{all}$–0.49	U_{all}–0.69	$SHGC_{all}$–0.49	U_{all}–1.36	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–0.69	$SHGC_{all}$–0.39	U_{all}–0.69	$SHGC_{all}$–0.39	U_{all}–1.36	$SHGC_{all}$–NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.
[a]When using R-value compliance method, a thermal spacer block is required; otherwise use the U-factor compliance method. See Table A2.3.
[~~a~~b]Exception to Section A3.1.3.1 applies.
[~~b~~c]Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
[~~c~~d]Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Figure 14: Building Envelope Requirements for Climate Zone 5

TABLE 5.5-6 Building Envelope Requirements For Climate Zone 6 (A, B)*

Opaque Elements	Nonresidential Assembly Maximum	Nonresidential Insulation Min. R-Value	Residential Assembly Maximum	Residential Insulation Min. R-Value	Semiheated Assembly Maximum	Semiheated Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.093	R-10.0 c.i.
Metal Building[a]	~~U-0.065~~ U-0.049	~~R-19.0~~ R-13.0 + R-19.0	~~U-0.065~~ U-0.049	~~R-19.0~~ R-13.0 + R-19.0	~~U-0.097~~ U-0.072	~~R-10.0~~ R-16.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.034	R-30.0
Walls, Above-Grade						
Mass	U-0.080	R-13.3 c.i.	U-0.071	R-15.2 c.i.	U-0.151[a]	R-5.7 c.i.[a]
Metal Building	~~U-0.113~~ U-0.069	~~R-13.0~~ R-13.0 + R-5.6 c.i.	~~U-0.057~~ U-0.069	~~R-13.0 + R-13.0~~ R-13.0 + R-5.6 c.i.	U-0.113	R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.051	R-13.0 + R-7.5 c.i.	U-0.051	R-13.0 + R-7.5 c.i.	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-0.119	R-7.5 c.i.	C-0.119	R-7.5 c.i.	C-1.140	NR
Floors						
Mass	U-0.064	R-12.5 c.i.	U-0.057	R-14.6 c.i.	U-0.137	R-4.2 c.i.
Steel-Joist	U-0.038	R-30.0	U-0.032	R-38.0	U-0.052	R-19.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-.0051	R-19.0
Slab-On-Grade Floors						
Unheated	F-0.540	R-10 for 24 in.	F-0.520	R-15 for 24 in.	F-0.730	NR
Heated	F-0.860	R-15 for 24 in.	F-0.688	R-20 for 48 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	
Fenestration	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**
Vertical Glazing, 0%–40% of Wall						
Nonmetal framing (all)[b,c]	U-0.35	SHGC-0.40 all	U-0.35	SHGC-0.40 all	U-0.65	SHGC-NR all
Metal framing (curtainwall/storefront)[c,d]	U-0.45		U-0.45		U-0.60	
Metal framing (entrance door)[c,d]	U-0.80		U-0.80		U-0.90	
Metal framing (all other)[c,d]	U-0.55		U-0.55		U-0.65	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}–1.17	$SHGC_{all}$–0.49	U_{all}–0.98	$SHGC_{all}$–0.46	U_{all}–1.98	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.17	$SHGC_{all}$–0.49	U_{all}–0.98	$SHGC_{all}$–0.36	U_{all}–1.98	$SHGC_{all}$–NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}–0.87	$SHGC_{all}$–0.71	U_{all}–0.74	$SHGC_{all}$–0.65	U_{all}–1.90	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–0.87	$SHGC_{all}$–0.58	U_{all}–0.74	$SHGC_{all}$–0.55	U_{all}–1.90	$SHGC_{all}$–NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}–0.69	$SHGC_{all}$–0.49	U_{all}–0.58	$SHGC_{all}$–0.49	U_{all}–1.36	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–0.69	$SHGC_{all}$–0.49	U_{all}–0.58	$SHGC_{all}$–0.39	U_{all}–1.36	$SHGC_{all}$–NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.
[a]When using R-value compliance method, a thermal spacer block is required; otherwise use the U-factor compliance method. See Table A2.3.
[b]Exception to Section A3.1.3.1 applies.
[c]Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
[d]Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Figure 15: Building Envelope Requirements for Climate Zone 6

TABLE 5.5-7 Building Envelope Requirements For Climate Zone 7*

Opaque Elements	Nonresidential Assembly Maximum	Nonresidential Insulation Min. R-Value	Residential Assembly Maximum	Residential Insulation Min. R-Value	Semiheated Assembly Maximum	Semiheated Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.093	R-10.0 c.i.
Metal Building[a]	U-0.065 U-0.049	R-19.0 R-13.0 + R-19.0	U-0.065 U-0.049	R-19.0 R-13.0 + R-19.0	U-0.097 U-0.072	R-10.0 R-16.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.034	R-30.0
Walls, Above-Grade						
Mass	U-0.071	R-15.2 c.i.	U-0.071	R-15.2 c.i.	U-0.123	R-7.6 c.i.
Metal Building	U-0.057	~~R-13.0 + R-13.0~~ R-19.0 + R-5.6 c.i.	U-0.057	~~R-13.0 + R-13.0~~ R-19.0 + R-5.6 c.i.	U-0.113	R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.042	R-13.0 + R-15.6 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.051	R-13.0 + R-7.5 c.i.	U-0.051	R-13.0 + R-7.5 c.i.	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-0.119	R-7.5 c.i.	C-0.092	R-10.0 c.i.	C-1.140	NR
Floors						
Mass	U-0.064	R-12.5 c.i.	U-0.051	R-16.7 c.i.	U-0.107	R-6.3 c.i.
Steel-Joist	U-0.038	R-30.0	U-0.032	R-38.0	U-0.052	R-19.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.051	R-19.0
Slab-On-Grade Floors						
Unheated	F-0.520	R-15 for 24 in.	F-0.520	R-15 for 24 in.	F-0.730	NR
Heated	F-0.843	R-20 for 24in.	F-0.688	R-20 for 48 in.	F-0.900	R-10 for 24 in.
Opaque Doors						
Swinging	U-0.500		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	
Fenestration	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**
Vertical Glazing, 0%–40% of Wall						
Nonmetal framing (all)[b,c]	U-0.35	SHGC-0.45 all	U-0.35	SHGC-NR all	U-0.65	SHGC-NR all
Metal framing (curtainwall/storefront)[c,d]	U-0.40		U-0.40		U-0.60	
Metal framing (entrance door)[c,d]	U-0.80		U-0.80		U-0.90	
Metal framing (all other)[c,d]	U-0.45		U-0.45		U-0.65	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}–1.17	$SHGC_{all}$–0.68	U_{all}–1.17	$SHGC_{all}$–0.64	U_{all}–1.98	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–1.17	$SHGC_{all}$–0.64	U_{all}–1.17	$SHGC_{all}$–0.64	U_{all}–1.98	$SHGC_{all}$–NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}–0.87	$SHGC_{all}$–0.77	U_{all}–0.61	$SHGC_{all}$–0.77	U_{all}–1.90	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–0.87	$SHGC_{all}$–0.71	U_{all}–0.61	$SHGC_{all}$–0.77	U_{all}–1.90	$SHGC_{all}$–NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}–0.69	$SHGC_{all}$–0.68	U_{all}–0.69	$SHGC_{all}$–0.64	U_{all}–1.36	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–0.69	$SHGC_{all}$–0.64	U_{all}–0.69	$SHGC_{all}$–0.64	U_{all}–1.36	$SHGC_{all}$–NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.
[a]When using R-value compliance method, a thermal spacer block is required; otherwise use the U-factor compliance method. See Table A2.3.
[b]Exception to Section A3.1.3.1 applies.
[c]Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
[d]Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Figure 16: Building Envelope Requirements for Climate Zone 7

TABLE 5.5-8 Building Envelope Requirements For Climate Zone 8*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.063	R-15.0 c.i.
Metal Building[a]	~~U-0.049~~ U-0.035	~~R-13.0 + R-19.0~~ R-11.0 + R-19.0 ls	~~U-0.049~~ U-0.035	~~R-13.0 + R-19.0~~ R-11.0 + R-19.0 ls	~~U-0.072~~ U-0.065	~~R-16.0~~ R-19.0
Attic and Other	U-0.021	R-49.0	U-0.021	R-49.0	U-0.034	R-30.0
Walls, Above-Grade						
Mass	U-0.071	R-15.2 c.i.	U-0.052	R-25.0 c.i.	U-0.104	R-9.5 c.i.
Metal Building	U-0.057	~~R-13.0 + R-13.0~~ R-19.0 + R-5.6 c.i.	U-0.057	~~R-13.0 + R-13.0~~ R-19.0 + R-5.6 c.i.	U-0.113	R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.037	R-13.0 + R-18.8 c.i.	U-0.084	R-13.0 + R-3.8 c.i.
Wood-Framed and Other	U-0.036	R-13.0 + R-15.6 c.i.	U-0.036	R-13.0 + R-15.6 c.i.	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-0.119	R-7.5 c.i.	C-0.075	R-12.5 c.i.	C-1.140	NR
Floors						
Mass	U-0.057	R-14.6 c.i.	U-0.051	R-16.7 c.i.	U-0.087	R-8.3 c.i.
Steel-Joist	U-0.032	R-38.0	U-0.032	R-38.0	U-0.052	R-19.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.033	R-30.0
Slab-On-Grade Floors						
Unheated	F-0.520	R-15 for 24 in.	F-0.510	R-20 for 24 in.	F-0.730	NR
Heated	F-0.688	R-20 for 48 in.	F-0.688	R-20 for 48 in.	F-0.900	R-10.0 for 24 in.
Opaque Doors						
Swinging	U-0.500		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-0.500	
Fenestration	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**
Vertical Glazing, 0%–40% of Wall						
Nonmetal framing (all)[~~b~~c]	U-0.35		U-0.35		U-0.65	
Metal framing (curtainwall/storefront)[~~c~~d]	U-0.40	SHGC-0.45 all	U-0.40	SHGC-NR all	U-0.60	SHGC-NR all
Metal framing (entrance door)[~~c~~d]	U-0.80		U-0.80		U-0.90	
Metal framing (all other)[~~c~~d]	U-0.45		U-0.45		U-0.65	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}–0.98	$SHGC_{all}$–NR	U_{all}–0.98	$SHGC_{all}$–NR	U_{all}–1.30	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–0.98	$SHGC_{all}$–NR	U_{all}–0.98	$SHGC_{all}$–NR	U_{all}–1.30	$SHGC_{all}$–NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}–0.61	$SHGC_{all}$–NR	U_{all}–0.61	$SHGC_{all}$–NR	U_{all}–1.10	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–0.61	$SHGC_{all}$–NR	U_{all}–0.61	$SHGC_{all}$–NR	U_{all}–1.10	$SHGC_{all}$–NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}–0.58	$SHGC_{all}$–NR	U_{all}–0.58	$SHGC_{all}$–NR	U_{all}–0.81	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–0.58	$SHGC_{all}$–NR	U_{all}–0.58	$SHGC_{all}$–NR	U_{all}–0.81	$SHGC_{all}$–NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.

[a] When using R-value compliance method, a thermal spacer block is required; otherwise use the U-factor compliance method. See Table A2.3.

[~~a~~b] Exception to Section A3.1.3.1 applies.

[~~b~~c] Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.

[~~c~~d] Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Figure 17: Building Envelope Requirements for Climate Zone 8

A2.3 Metal Building Roofs

A2.3.1 General. For the purpose of A1.2, the base assembly is a roof with thermal spacer blocks where the insulation is draped over the steel structure (purlins), spaced nominally 5 ft on center and then compressed when the metal roof panels are attached to the steel structure (purlins).

A2.3.2 Rated R-Value of insulation

A2.3.2.1 The first rated R-value of insulation is for insulation draped over purlins and then compressed when the metal roof panels are attached, or for insulation hung between the purlins. A minimum R-3.51. thermal spacer block between the purlins and the metal roof panels is required when specified in Table A2.3.

A2.3.2.2 For double-layer installations, the second rated R-value of insulation is for insulation installed parallel to the purlins.

A2.3.2.3 For continuous insulation (e.g., insulation boards or blankets), it is assumed that the insulation is installed below the purlins and is uninterrupted by framing members. Insulation exposed to the conditioned space or semi-heated space shall have a facing, and all insulation seams shall be continuously sealed to provide a continuous air barrier.

A2.3.2.4 Liner System (Ls). A continuous vapor barrier liner is installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the liner between the purlins. For multilayer installations, the first rated R-Value of insulation is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached. A minimum R-3.5 thermal spacer block between the purlins and the metal roof panels is required when specified in Table A2.3 (Figure 19).

A2.3.3 U-Factor. U-factors for metal building roofs shall be taken from Table A2.3 (Figure 19) It is not acceptable to use these U-factors if additional insulated sheathing is not continuous.

Exception to A3.1.3.1: For mass walls, where the requirement in Tables 5.5-1(Figure 10) through 5.5-8 (Figure 17) is for a maximum assembly U-0.151 followed by footnote "ab," .

TABLE A3.2 Assembly U-Factors for Metal Building Walls

Insulation System	Rated R-Value of Insulation	Total Rated R-Value of Insulation	Overall U-Factor for Entire Base Wall Assembly	Overall U-Factor for Assembly of Base Wall Plus Continuous Insulation (Uninterrupted by Framing) Rated R-Value of Continuous Insulation					
				R-5.6	R-11.2	R-16.8	R-22.4	R-28.0	R-33.6
Single Layer of Mineral Fiber									
	None	0	1.180	0.161	0.086	0.059	0.045	0.036	0.030
	R-6	6	0.184	0.091	0.060	0.045	0.036	0.030	0.026
	R-10	10	0.134	0.077	0.054	0.051	0.033	0.028	0.024
	R-11	11	0.123	0.073	0.052	0.040	0.033	0.028	0.024
	R-13	13	0.113	0.069	0.050	0.039	0.032	0.027	0.024
	R-16	16	0.093	0.061	0.046	0.036	0.030	0.026	0.023
	R-19	19	0.084	0.057	0.043	0.035	0.029	0.025	0.022
Double Layer of Mineral Fiber									
(Second layer inside of girts)									
(Multiple layers are listed in order from inside to outside)									
	R-6 + R-13	19	0.070	N/A	N/A	N/A	N/A	N/A	N/A
	R-10 + R-13	23	0.061	N/A	N/A	N/A	N/A	N/A	N/A
	R-13 + R-13	26	0.057	N/A	N/A	N/A	N/A	N/A	N/A
	R-19 + R-13	32	0.048	N/A	N/A	N/A	N/A	N/A	N/A

Figure 18: Assembly U-Factors for Metal Building Walls

TABLE A2.3 Assembly U-Factors for Metal Building Roofs

Insulation System	Rated R-Value of Insulation	Total Rated R-Value of Insulation	Overall U-Factor for Entire Base Roof Assembly	Overall U-Factor for Assembly of Base Roof Plus Continuous Insulation (Uninterrupted by Framing) — Rated R-Value of Continuous Insulation: R-5.6	R-11.2	R-16.8	R-22.4	R-28.0	R-33.6
Standing Seam Roofs with Thermal Spacer Blocks									
Single Layer	None	0	**U-1.280**	~~0.162~~ 0.157	~~0.087~~ 0.083	~~0.059~~ 0.057	~~0.045~~ 0.043	~~0.036~~ 0.035	~~0.030~~ 0.029
	R-6	6	**U-0.167**	0.086	0.058	0.044	0.035	0.029	0.025
	R-10	10	**U-0.097**	0.063	0.046	0.037	0.031	0.026	0.023
	R-11	11	**U-0.092**	0.061	0.045	0.036	0.030	0.026	0.022
	R-13	13	**U-0.083**	0.057	0.043	0.035	0.029	0.025	0.022
	R-16	16	**U-0.072**	0.051	0.040	0.033	0.028	0.024	0.021
	R-19	19	**U-0.065**	0.048	0.038	0.031	0.026	0.023	0.020
Double Layer	R-10 + R-10	20	**U-0.063**	0.047	0.037	0.031	0.026	0.023	0.020
	R-10 + R-11	21	**U-0.061**	0.045	0.036	0.030	0.026	0.023	0.020
	R-11 + R-11	22	**U-0.060**	0.045	0.036	0.030	0.026	0.022	0.020
	R-10 + R-13	23	**U-0.058**	0.044	0.035	0.029	0.025	0.022	0.020
	R-11 + R-13	24	**U-0.057**	0.043	0.035	0.029	0.025	0.022	0.020
	R-13 + R-13	26	**U-0.055**	0.042	0.034	0.029	0.025	0.022	0.019
	R-10 + R-19	29	**U-0.052**	0.040	0.033	0.028	0.024	0.021	0.019
	R-11 + R-19	30	**U-0.051**	0.040	0.032	0.027	0.024	0.021	0.019
	R-13 + R-19	32	**U-0.049**	0.038	0.032	0.027	0.023	0.021	0.019
	R-16 + R-19	35	**U-0.047**	0.037	0.031	0.026	0.023	0.020	0.018
	R-19 + R-19	38	**U-0.046**	0.037	0.030	0.026	0.023	0.020	0.018
Liner System	R-11 + R-19	30	**U-0.035**						
	R-11 + R-25	36	**U-0.031**						
	R-11 + R-30	41	**U-0.029**						
	R-11 + R-11 + R-25	47	**U-0.026**						
Standing Seam Roofs without Thermal Spacer Blocks									
Liner System	R-11 + R-19	30	**U-0.040**		0.028	0.024	0.021	0.020	0.017
Filled Cavity with Thermal Spacer Blocks									
	R-19 + R-10	29	**U-0.041**	0.033	0.028	0.024	0.021	~~0.020~~0.019	0.017
(Multiple R-values are listed in order from inside to outside.)									
Thru-Fastened without Thermal Spacer Blocks									
	R-10	10	**U-0.153**						
	R-11	11	**U-0.139**						
	R-13	13	**U-0.130**						
	R-16	16	**U-0.106**						
	R-19	19	**U-0.098**						
Liner System	R-11 + R-19	30	**U-0.044**						

Figure 19: Assembly U-Factors for Metal Building Roofs

Addendum q: This addendum modifies the vestibule requirements for Climate Zone 4.

5.4.3.4 Vestibules. Building entrances that separate conditioned space from the exterior shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule, it is not necessary for the interior and exterior doors to open at the same time. Interior and exterior doors shall have a minimum distance between them of not less than 7 ft (2.1 m) when in the closed position. The exterior envelope of conditioned vestibules shall comply with the requirements for a conditioned space. The interior and exterior envelope of unconditioned vestibules shall comply with the requirements for a semi-heated space.
Exceptions:
a. Building entrances with revolving doors.
b. Doors not intended to be used as a building entrance.
c. Doors opening directly from a dwelling unit.
d. Building entrances in buildings located in climate zone 1 or 2.
e. Building entrances in buildings located in climate zone 3 or 4 that are less than four stories above grade and less than 10,000 ft2 (930 m2) in area.
f. Building entrances in buildings located in climate zone 4, 5, 6, 7, or 8 that are less than 1000 ft2 (90 m2) in area.
g. Doors that open directly from a space that is less than 3000 ft2 (280 m2) in area and is separate from the building entrance.

Discussions:
Comparing 2009 IECC with ASHRAE 90.1 2010 draft: A comparison was made between 2009 IECC and the proposed criteria tables for the ASHRAE 90.1 2010. Details include: CZ 1, skylight U-factors: 6 of the proposed values are less stringent than the 2009 IECC CZ 2, skylight U-factors: 4 of the proposed values are less stringent than the 2009 IECC CZ 3, skylight U-factors: 6 of the proposed values are less stringent than the 2009 IECC CZ 3, skylight SHGC: 3 of the proposed values are less stringent than the 2009 IECC CZ 4, skylight U-factors: 4 of the proposed values are less stringent than the 2009 IECC CZ 4, skylight SHGC: 4 of the proposed values are less stringent than the 2009 IECC CZ 5, skylight U-factors: 4 of the proposed values are less stringent than the 2009 IECC CZ 5, skylight SHGC: 6 of the proposed values are less stringent than the 2009 IECC CZ 6, skylight U-factors: 4 of the proposed values are less stringent than the 2009 IECC CZ 6, skylight SHGC: 6 of the proposed values are less stringent than the 2009 IECC CZ 7, skylight U-factors: 4 of the proposed values are less stringent than the 2009 IECC CZ 8, skylight U-factors: 4 of the proposed values are less stringent than the 2009 IECC CZ 8, mass wall U-factors: 2 of the proposed values are less stringent than the 2009 IECC.

Incorporating high-performance metal frames into the criteria for envelope selection in the ASHRAE 90.1 Standard: Previously, the calculations were lacking data for the high performance metal frame. This was skewing the fenestration results since the optimization spreadsheet was selecting that product in most cases, carrying through the placeholder numbers, even though they were estimates and not real. More information is now obtained from both thermal break manufacturers and heavy commercial window manufacturers about more representative frame U-factors for high performance framing. For curtainwall, the frame U-factor had to be increased somewhat, because of the heavier and deeper frames used in curtainwall to compensate for the decrease in structural performance from adding a wider thermal break. In the end, for the high performance frame with an insulating spacer, a Uf = 1.0 was put for curtainwall and Uf = 0.74 for windows. Costs of high performance frames have yet to be obtained.

Incorporating prescriptive values for Vt and SHGC: PNA and AGC ask the Committee to reconsider its preliminary decision to include VT/SHGC in the standard. Its inclusion is arbitrary and has no rational relationship to its intended purpose. The only thing it does is to unfairly discriminate against moderate glare-control low-e products in favor of clear low-e products. In that regard, it clearly does not reduce lighting loads since a larger piece of medium VT glass that does not meet the Committee's VT/SHGC can deliver exactly the same number of lumens to a work space within a building as a smaller piece of clear glass that does meet the proposed VT/SHGC requirement. Likewise, it is uncertain whether it will even save any energy. In that regard, the Committee has not assessed and, indeed, has no basis upon which to assess, whether the inclusion of a prescriptive VT/SHGC value will save any energy. The criteria generator that the Committee uses to evaluate whether or not energy is saved does not include VT in the energy savings calculation. While it does include the effect of lighting controls (even where lighting controls are not required by the standard - which raises additional questions), there is no quantification of the energy savings to determine whether the savings are insignificant or not, or even positive or negative in any climate zone.

PNA's and AGC's comments in opposition to the inclusion of VT/SHGC are not resolved. Its inclusion unfairly and irrationally discriminates by precluding the use of numerous glazing products that perform equally to those that will be permitted under the Committee's proposed 1.5 VT/SHGC. Further, a technically sound alternative that does not unfairly discriminate against those products exists and can be used, namely, effective apperture.

PNA and AGC submit that the dislike of glare control low-e glass by some members of the Committee does not warrant the time, cost and expense that will ultimately be involved if PNA and AGC are forced to pursue their objections. Accordingly, we ask that the Committee reconsider its preliminary decision to include VT/SHGC and its preliminary decision to reject consideration of effective apperture as an alternative.

Reducing the allowable window to wall area ratio for the envelope base-case: The discussion on reduction of window-to-wall area ratio opposed the idea because properly designed windows and skylights can improve energy performance and help our buildings be habitable during power outages and other emergencies. Windows are also an amenity, just like floor area or volume. Another discussion upholding this idea was to incorporate the variations in vertical fenestration usage.

5.2.2.2 From the Mechanical Subcommittee

Several addenda were passed by this subcommittee to modify the ASHRAE 90.1 2007 code. Addendum a seeks to clarify that the current cooling tower requirements in the Standard apply to open-circuit cooling towers only. Addendum b updates the references for outdoor ventilation rates. Addendum c adds vivariums to the list of spaces that require specific humidity levels to satisfy process needs. Addendum h adds a new exception that is geared toward zones with direct digital controls (DDC). Addendum k specifies specific sections of reference standards in Tables 6.8.1E (Figure 21) and 7.8 (Figure 22). Addendum l adds minimum efficiency and certification requirements for both axial and centrifugal fan closed-circuit cooling towers (also known as *fluid coolers*) to Table 6.8.1G (Figure 23). In addition, a reference to ATC-105S, the Cooling Technology Institute test standard for closed-circuit cooling towers, has been added to Section 12, Normative References. Addendum m establishes effective January 1, 2010, an additional path of compliance for water-cooled chillers and also combines all water-cooled positive displacement chillers into one category and adds a new size category for centrifugal chillers at or above 600 tons. Addendum n extends variable air volume fan control requirements to large single-zone units. Addendum p addresses fan power limitations to all fan systems with exceptions to those serving fume hoods. Addendum s updates the COP at 17^0F efficiency levels for commercial heat pumps and introduces a new part load energy efficiency descriptor for all commercial unitary products above 65,000 Btu/hr of cooling capacity. Addendum t removes the term “replacement” and “new construction” from the product classes listed in Table 6.8.1D (Figure 28) and replaces them with the terms “non-standard size” and “standard size”, respectively, to clarify that one product class is intended for applications with non-standard size exterior wall openings while the other is intended for applications with standard size exterior wall openings. The addendum also amends Section 6.4.1.5.2 and footnote b to Table 6.8.1D (Figure 28) to clarify that non-standard size packaged terminal equipment have sleeves with an external wall opening less than 16 in. high or less than 42 in. wide to reflect existing applications where the wall opening is not necessarily less than 16 in. high and less than 42 in. wide. Addendum u adds requirements for axial fan open-circuit cooling towers. Addendum ad adds requirements for liquid to liquid heat exchangers and adds a reference to AARI 400-2008.

Addenda:
Addendum a: Efficiency and certification requirements for open cooling towers were first incorporated into the 2001 edition of Standard 90.1. At the time, closed circuit cooling towers were known as “fluid coolers” with no established certification program and were not covered by these requirements. Since then,

fluid coolers have become known as “closed circuit cooling towers” and the Cooling Technology Institute adopted a certification standard that covers this equipment. This has led to confusion in the industry with consulting engineers and inspectors on occasion trying to apply the current open circuit cooling tower requirements in the standard to closed circuit cooling towers. This addendum seeks to clarify that the current cooling tower requirements in the standard apply to open circuit cooling towers only, until such time that separate requirements for closed circuit cooling towers are established in the standard.
Changes are presented in the tables below:

TABLE 6.8.1G Performance Requirements for Heat Rejection Equipment

Equipment Type[d]	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required[a,b]	Test Procedure[c]
Propeller or Axial Fan Open Cooling Towers	All	95°F Entering Water 85°F Leaving Water 75°F wb *Outdoor air*	38.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal Fan Open Cooling Towers	All	95°F Entering Water 85°F Leaving Water 75°F wb *Outdoor air*	20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Air-Cooled Condensers	All	125°F Condensing Temperature R-22 Test Fluid 190°F Entering Gas Temperature 15°F Subcooling 95°F Entering db	176,000 Btu/h·hp	ARI 460

[a] For purposes of this table, *open cooling tower performance* is defined as the ~~maximum~~ flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the fan nameplate rated motor power.

[b] For purposes of this table, *air-cooled condenser performance* is defined as the heat rejected from the refrigerant divided by the fan nameplate rated motor power.

[c] Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

[d] The efficiencies for open cooling towers listed in Table 6.8.1G are not applicable for closed-circuit cooling towers.

Figure 20: Performance Requirements for Heat Rejection Equipment

Addendum b: Some facilities covered by Standard 90.1 are challenged to demonstrate compliance with fan power limitations requirements of Standard 90.1 while including design features protecting the safety of inhabitants and compliance of other applicable standards, codes, laws, or regulations. These facilities often require compliance with NIH, NFPA, and other standards with air control and conditioning more stringent than Standard 90.1 and 62.1 requirements. An example of these facilities is vivariums. In exception section 6.5.2.3 (a) of Standard 90.1-2004, the reference to the requirements of Standard 62.1 as the minimum ventilation required is an example of this conflict. This addendum corrects the reference by eliminating the specific section and denoting only Standard 62.1 and allows for another, higher outdoor ventilation rate to be set by the regulating body for these specific applications.
Changes are provided in the table below:

6.5.2.3
Exceptions:
a. The system is capable of reducing supply air volume to 50% or less of the design airflow rate or the minimum outdoor air ventilation rate specified in 6.2 of ASHRAE Standard 62.1 or other applicable federal, state or local code or recognized standard, whichever is larger, before simultaneous heating and cooling takes place.

Addendum c: Some facilities covered by Standard 90.1 are challenged to demonstrate compliance with fan power limitations requirements of Standard 90.1 while including design features protecting the safety of inhabitants and compliance of other applicable standards, codes, laws, or regulations. These facilities often require compliance with NIH, NFPA, and other standards with air control and conditioning more stringent than Standard 90.1 and 62.1 requirements. An example of these facilities is vivariums. In ASHRAE Standard 90.1-2004 Section 6.5.2.3, Exception (d), this application was not included. This addendum adds vivariums to the list of spaces that require specific humidity levels to satisfy process needs.
Changes are provided in the table below:

6.5.2.3

Exceptions:
d. Systems serving spaces where specific humidity levels are required to satisfy process needs such as vivariums, museums, surgical suites and buildings with refrigerating systems such as supermarkets, refrigerated warehouses and ice arenas. This exception also applies to other applications for which fan volume controls in accordance with Exception (a) are proven to be impractical to the enforcement agency.

Addendum h: This change includes a new exception to Section 6.5.2.1 that is geared toward zones with direct digital controls (DDC).The new exception (exception b) largely addresses the apparent conflict between Standards 55, 62.1, and 90.1, and also takes advantage of the energy-saving potential of DDC controls in order to save about $0.20/ft2/yr with a simple payback of less than two years. The apparent conflict is that the current 30% reheat maximum typically requires very high supply air temperatures (e.g., >100°F) to meet peak heating load. High supply air temperatures result in poor comfort per Standard 55 and poor ventilation effectiveness per Standard 62.1. The new exception allows reheat to increase from 30% to 50%, which means lower supply air temperatures and better comfort and ventilation effectiveness. The energy savings come from the fact that maximum airflow in deadband is being lowered from 30% to 20%. This saves fan energy and cooling energy in deadband, and also reduces the amount of time when the zone will be overcooled in deadband and forced into reheat.

This new exception will also alleviate a common problem where engineers feel compelled to violate the current 30% exception in order to provide adequate heating. In addition to poor comfort and ventilation effectiveness, high supply air temperatures also lead to short-circuiting. When hot supply air short circuits directly from the supply to the return, the space takes longer to warm up and may not warm up at all. Therefore, it is very common for designers and contractors to disregard the current 30% requirement and use 40% or 50% minimum flow setpoints to ensure adequate heating. No one likes to disregard the code, but if the choice is between code and comfort, comfort wins. The new exception allows users to achieve comfort, meet the code, and save energy at minimal cost.

Because not all zones have DDC controls and because this is a fairly significant shift in zone controls, the existing 30% exception is left in the standard. However, two clauses from the existing exception are deleted. The 0.4 cfm/ft2 exception is deleted because it implies that a minimum air speed in the occupied space is required for comfort. ASHRAE Standard 55, however, indicates that no minimum air speed is required for comfort. Furthermore, 0.4 cfm/ft2 does not guarantee any particular air speed because 0.4 cfm/ft2 can be a small fraction (e.g., 10%) or a large fraction (e.g., 50%) of the design flow rate and, thus, can result in a low or high airspeed. The 300 cfm exception is deleted because the situation that it was intended to address has been largely eliminated by the new 50% exception described above. This criterion was intended to address the following applications: the occasional small zone in a VAV reheat system for which 30% is insufficient to handle heating loads, such as spaces with large north-facing glass areas.

Exceptions to 6.5.2.1:
a. Zones for which the volume of air that is reheated, re-cooled, or mixed is less than the larger of the following:
1. 30% of the zone design peak supply rate;
2. The volume of outdoor air required to meet the ventilation requirements of Section 6.2 of ASHRAE Standard 62.1 for the zone;
3. Any higher rate that can be demonstrated, to the satisfaction of the authority having jurisdiction, to reduce overall system annual energy usage by offsetting reheat/re-cool energy losses through a reduction in outdoor air intake.

b. Zones that comply with all of the following:
1. The volume of air that is reheated, re-cooled, or mixed in dead band between heating and cooling does not exceed the larger of the following:
a. 20% of the zone design peak supply rate;
b. the volume of outdoor air required to meet the ventilation requirements of Section 6.2 of ASHRAE Standard 62.1 for the zone;
c. any higher rate that can be demonstrated, to the satisfaction of the authority having jurisdiction, to reduce overall system annual energy usage by offsetting reheat/re-cool energy losses through a reduction in outdoor air intake.

2. The volume of air that is reheated, re-cooled, or mixed in peak heating demand shall be less than 50% of the zone design peak supply rate.
3. Airflow between dead band and full heating or full cooling shall be modulated.

c. Zones where special pressurization relationships, cross-contamination requirements, or code-required minimum circulation rates are such that variable-air volume systems are impractical.
d. Zones where at least 75% of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered (including condenser heat) or site- solar energy source.

Addendum k: This addendum revises Tables 6.8.1E (Figure 21) and 7.8 (Figure 22) in ANSI/ASHRAE/IESNA Standard 90.1-2007, identifying the specific sections of the referenced standards. Table 7.8 (Figure 22) is also updated to reflect the current federal efficiency levels for residential water heaters. Additionally, a requirement in Table 7.8 (Figure 22) for electric table top water heaters has been added.

TABLE 6.8.1E Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces, and Unit Heaters

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Warm Air Furnace, Gas-Fired	<225,000 Btu/h		78% AFUE or 80% E_{td}	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, of ANSI Z21.47
	≥225,000 Btu/h	Maximum Capacity[d]	80% E_{cc}	Section 2.39, Thermal Efficiency, of ANSI Z21.47
Warm Air Furnace, Oil-Fired	<225,000 Btu/h		78% AFUE or 80% E_{td}	DOE 10 CFR Part 430 or Section 42, Combustion, of UL 727
	≥225,000 Btu/h	Maximum Capacity[e]	81% E_{tf}	Section 42, Combustion, of UL 727
Warm Air Duct Furnaces, Gas- Fired	All Capacities	Maximum Capacity[e]	80% E_{cg}	Section 2.10, Efficiency, of ANSI Z83.~~9~~8
Warm Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity[e]	80% E_{cg}	Section 2.10, Efficiency, of ANSI Z83.8
Warm Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity[e]	80% E_{cg}	Section 40, Combustion, of UL 731

[a] E_t= thermal *efficiency*. See test procedure for detailed discussion.
[b] Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
[c] E_c = combustion *efficiency*. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
[d] Combination units not covered by NAECA (three-phase power or cooling capacity greater than or equal to 65,000 Btu/h) may comply with either rating.
[e] Minimum and maximum ratings as provided for and allowed by the unit's controls.
[f] E_t = thermal *efficiency*. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
[g] E_c = combustion *efficiency* (100% less flue losses). See test procedure for detailed discussion.

Figure 21: Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces, and Unit Heaters

TABLE 7.8 Performance Requirements for Water Heating Equipment

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Performance Required[a]	Test Procedure[b,c]
Electric Table Top Water Heaters	≤12 kW	Resistance ≥20 gal	0.93-0.00132V EF	DOE 10 CFR Part 430
Electric Water Heaters	≤12 kW	Resistance ≥20 gal	0.9~~3~~7-0.00132V EF	DOE 10 CFR Part 430
	>12 kW	Resistance≥20 gal	20 + 35 √V SL, Btu/h	Section G.2 of ANSI Z21.10.3
	≤24 Amps and ≤250 Volts	Heat Pump	0.93-0.00132V EF	DOE 10 CFR Part 430
Gas Storage Water Heaters	≤75,000 Btu/h	≥20 gal	0.6~~2~~7-0.0019V EF	DOE 10 CFR Part 430
	>75,000 Btu/h	<4000 (Btu/h)/gal	80% E_t (Q/800 + 110 √V) SL, Btu/h	Sections G.1 and G.2 of ANSI Z21.10.3
Gas Instantaneous Water Heaters	>50,000 Btu/h and <200,000 Btu/h	≥4000 (Btu/h)/gal and <2 gal	0.62-0.0019V EF	DOE 10 CFR Part 430
	≥200,000 Btu/h[~~c~~d]	≥4000 (Btu/h)/gal and <10 gal	80% E_t	Sections G.1 and G.2 of ANSI Z21.10.3
	≥200,000 Btu/h	≥4000 (Btu/h)/gal and ≥10 gal	80% E_t (Q/800 + 110 √V) SL, Btu/h	
Oil Storage Water Heaters	≤105,000 Btu/h	≥20 gal	0.59-0.0019V EF	DOE 10 CFR Part 430
	>105,000 Btu/h	<4000 (Btu/h)/gal	78% E_t (Q/800 + 110 √V) SL, Btu/h	Sections G.1 and G.2 of ANSI Z21.10.3
Oil Instantaneous Water Heaters	≤210,000 Btu/h	≥4000 (Btu/h)/gal and <2 gal	0.59-0.0019V EF	DOE 10 CFR Part 430
	>210,000 Btu/h	≥4000 (Btu/h)/gal and <10 gal	80% E_t	Sections G.1 and G.2 of ANSI Z21.10.3
	>210,000 Btu/h	≥4000 (Btu/h)/gal and ≥10 gal	78% E_t (Q/800 + 110 √V) SL, Btu/h	
Hot Water Supply Boilers, Gas and Oil	≥300,000 Btu/h and <12,500,000 Btu/h	≥4000 (Btu/h)/gal and <10 gal	80% E_t	Sections G.1 and G.2 of ANSI Z21.10.3
Hot Water Supply Boilers, Gas		≥4000 (Btu/h)/gal and ≥10 gal	80% E_t (Q/800 + 110 √V) SL, Btu/h	
Hot Water Supply Boilers, Oil		≥4000 (Btu/h)/gal and ≥10 gal	78% E_t (Q/800 + 110 √V) SL, Btu/h	
Pool Heaters Oil and Gas	All		78% E_t	ASHRAE 146
Heat Pump Pool Heaters	All		4.0 COP	ASHRAE 146
Unfired Storage Tanks	All		R-12.5	(none)

[a] Energy factor (EF) and thermal efficiency (E_t) are minimum requirements, while standby loss (SL) is maximum Btu/h based on a 70°F temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in gallons. In the SL equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h.
[b] Section 12 contains a complete specification, including the year version, of the referenced test procedure.
[c] Section G1 is titled "Test Method for Measuring Thermal Efficiency" and Section G2 is titled "Test Method for Measuring Standby Loss."
[~~c~~d] Instantaneous water heaters with input rates below 200,000 Btu/h must comply with these requirements if the water heater is designed to heat water to temperatures 180°F or higher.

Figure 22: Performance Requirements for Water Heating Equipment

Addendum l: The purpose of this addendum is to add minimum efficiency and certification requirements for both axial and centrifugal fan closed-circuit cooling towers (also known as fluid coolers) into Table 6.8.1G (Figure 23). In addition, a reference to ATC-105S, The Cooling Technology Institute (CTI) test standard for closed-circuit cooling towers, has been added to Section 12, Normative References. A subcommittee of ASHRAE TC 8.6, Technical Committee on Cooling Towers and Evaporative Condensers, developed this addendum, which has been unanimously supported by the entire TC. Closed-circuit cooling

towers differ from open-circuit cooling towers in that the process fluid is kept isolated from the open loop spray water and airflow by an intermediate heat exchanger, typically a coil.
Closed-circuit devices also have an integral spray pump to re-circulate the spray water over the coil. To account for this, the gpm/hp value for closed-circuit cooling towers includes both the unit fan and spray pump motors, where hp equals the sum of the fan motor and integral spray pump motor nameplate horsepower. Lastly, the minimum efficiency values for closed-circuit cooling towers are based on typical water-source heat pump conditions, as the water-source heat pump industry is the largest HVAC market for this type of equipment.
The addition of minimum efficiency and certification requirements will provide consulting engineers, system designers, and contractors guidelines for the selection of independently certified, energy-efficient closed-circuit cooling towers. This change will also complement the existing minimum efficiency and certification requirements for open-circuit cooling towers, helping to prevent confusion between the requirements for these two different types of cooling towers.

TABLE 6.8.1G Performance Requirements for Heat Rejection Equipment

Equipment Type[~~d~~]	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required[a,b,c]	Test Procedure[~~cd~~,e]
Propeller or Axial Fan Open-Circuit Cooling Towers	All	95°F Entering Water 85°F Leaving Water 75°F ~~wb~~ ~~*Outdoor air*~~ *Entering wb*	≥38.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal Fan Open-Circuit Cooling Towers	All	95°F Entering Water 85°F Leaving Water 75°F ~~wb~~ ~~*Outdoor air*~~ *Entering wb*	≥20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or Axial Fan Closed-Circuit Cooling Towers	All	102°F Entering Water 90°F Leaving Water 75°F *Entering wb*	≥14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal Closed-Circuit Cooling Towers	All	102°F Entering Water 90°F Leaving Water 75°F *Entering wb*	≥7.0 gpm/hp	CTI ATC-105S and CTI STD-201
Air-Cooled Condensers	All	125°F Condensing Temperature R-22 Test Fluid 190°F Entering Gas Temperature 15°F Subcooling 95°F Entering db	≥176,000 Btu/h·hp	ARI 460

[a] For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the fan ~~nameplate rated~~ motor nameplate power.
[b] For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
[~~b~~c] For purposes of this table, *air-cooled condenser performance* is defined as the heat rejected from the refrigerant divided by the fan ~~nameplate rated~~ motor nameplate power.
[~~c~~d] Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
[~~d~~e] ~~The efficiencies for open cooling towers listed in Table 6.8.1G are not applicable for closed-circuit cooling towers.~~ The efficiencies and test procedures for both open- and closed-circuit cooling towers are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections.

Revise Section 12 as follows:

Reference	Title
CTI ATC-105 (00)	Acceptance Test Code for Water Cooling Towers
CTI ATC-105S (96)	Acceptance Test Code for Closed Circuit Cooling Towers
CTI STD-201 (04)	Standard for the Certification of Water-Cooling Tower Thermal Performance

Figure 23: Performance Requirements for Heat Rejection Equipment

Addendum m: Product development for water-cooled chillers in recent years has focused on improving both full-load and part-load performance. Variable-speed drives (VSDs) have gone through significant technology advancements and are now finding application in water-cooled chillers. The use of VSDs shows significant improvement of chiller integrated part-load value (IPLV). Improvements of up to 30% in IPLV are possible.

Partially offsetting the part-load performance improvement is a small decrease in full-load efficiency at design conditions, nominally up to 4%. The decrease in full-load efficiency is due to inherent electronic drive losses and power line-filters.
This addendum establishes—effective January 1, 2010—an additional path of compliance for water-cooled chillers.
Path A is intended for applications where significant operating time is expected at full-load conditions. On the other hand, Path B is an alternative set of efficiency levels for water-cooled chillers intended for applications where significant time is expected at part load. Compliance with the standard can be achieved by meeting the requirements of either Path A or Path B. However, both full-load and IPLV levels must be met to fulfill the requirements of Path A or Path B.
The addendum also combines all water-cooled positive displacement chillers into one category and adds a new size category for centrifugal chillers at or above 600 tons. The air-cooled chiller without condenser equipment category has been eliminated. All air-cooled chillers without condensers must now be rated with matching condensers. The minimum efficiencies of air-cooled chillers have also been updated. The minimum efficiencies for absorption chillers were left unchanged, as efficiencies have not improved over the last few years and the absorption market has been shrinking, with less than 150 units sold in the US in 2006. Efficiencies in the I-P version of the standard are now expressed in EER for air-cooled chillers, kW/ton for water-cooled chillers, and COP for absorption chillers to reflect industry practices. Tables 6.8.1H through 6.8.1J, listing minimum full-load and NPLV efficiencies of water-cooled centrifugal chillers at nonstandard rating conditions, have been eliminated and replaced by an algebraic equation. The tables will now be included in the 90.1 User's Manual.
The effective date of the new efficiency standards is January 1, 2010, to coincide with the phase-out date of HCFC-22 mandated under the Clean Air Act of 1992. This addendum is expected to save 457.6 GWh of energy per year compared to the requirements of ASHRAE/IESNA Standard 90.1-2004. This represents an annual energy saving of 13.3%.

6.4.1.2 Minimum Equipment Efficiencies—Listed Equipment—Nonstandard Conditions. Water-cooled centrifugal water-chilling packages that are not designed for operation at ARI Standard 550/590 test conditions (and thus cannot be tested to meet the requirements of Table 6.8.1C (Figure 24)) of 44°F leaving chilled-water temperature and 85°F entering condenser water temperature with 3 gpm/ton condenser water flow shall have maximum full-load kW/ton and *NPLV* ratings adjusted using the following equation:
Adjusted maximum full-load kW/ton rating = (full-load kW/ton from Table 6.8.1C (Figure 24))/*Kadj*
Adjusted maximum NPLV rating = (IPLV from Table 6.8.1C (Figure 24))/*Kadj*
where
$Kadj = 6.174722 – 0.303668(X) + 0.00629466(X)2– 0.000045780(X)3$
$X = DTstd + \text{LIFT}$
$DTstd$ = (24 + (full-load kW/ton from Table 6.8.1C (Figure 24)) × 6.83)/Flow
Flow = Condenser water flow (gpm)/Cooling full-load capacity (tons)
LIFT = CEWT – CLWT
CEWT = Full-load condenser entering water temperature(°F)
CLWT = Full-load leaving chilled-water temperature (°F)
The adjusted full-load and *NPLV* values are only applicable over the following full-load design ranges:
• Minimum Leaving Chiller-Water Temperature: 40°F to 48°F 38°F
• Maximum Condenser Entering Condenser Water Temperature:75°F to 85°F 102°F
• Condenser Water Temperature Rise: 5°F to 15°F Flow:1 to 6 gpm/ton
• $X \geq 39$°F and ≤ 60°F
Chillers designed to operate outside of these ranges or applications utilizing fluids or solutions with secondary coolants (e.g., glycol solutions or brines) with a freeze point of 27°F or lower for freeze protection are not covered by this standard.
Example: Path A 600 ton centrifugal chiller Table 6.8.1C efficiencies as of 1/1/2010
Full Load = 0.570 kW/ton
IPLV = 0.539 kW/ton
CEWT = 80°F
Flow = 2.5 gpm/ton
CLWT = 42°F

LIFT = 80 – 42 = 38°F
DT = (24 + 0.570 × 6.83)/2.5 = 11.16°F
X = 38 + 11.16 = 49.16°F
Kadj = 6.174772 – 0.303668(49.16) +0.00629466(49.16)2 – 0.00004578(49.16)3= 1.020
Adjusted full load = 0.570/1.020 = 0.559 kW/ton
NPLV = 0.539/1.020 = 0.528 kW/ton

Insert new Table 6.8.1C as follows and renumber the remaining tables appropriately.

TABLE 6.8.1C Water Chilling Packages—Efficiency Requirements[a]

Equipment Type	Size Category	Units	Before 1/1/2010		As of 1/1/2010[c]				Test Procedure[b]
					Path A		Path B		
			Full Load	IPLV	Full Load	IPLV	Full Load	IPLV	
Air-Cooled Chillers	≤150 tons	EER	≥9.562	≥10.416	≥9.562	≥12.500	NA[d]	NA[d]	ARI 550/590
	≥150 tons	EER			≥9.562	≥12.750	NA[d]	NA[d]	
Air-Cooled without Condenser, Electrical Operated	All Capacities	EER	≥10.586	≥11.782	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements				
Water Cooled, Electrically Operated, Reciprocating	All Capacities	kW/ton	≤0.837	≤0.696	Reciprocating units must comply with water cooled positive displacement efficiency requirements				
Water Cooled, Electrically Operated, Positive Displacement	≤75 tons	kW/ton	≤0.790	≤0.676	≤0.780	≤0.630	≤0.800	≤0.600	
	≥75 tons and ≤150 tons	kW/ton	≤0.790	≤0.676	≤0.775	≤0.615	≤0.790	≤0.586	
	≥150 tons and ≤300 tons	kW/ton	≤0.717	≤0.627	≤0.680	≤0.580	≤0.718	≤0.540	
	≥300 tons	kW/ton	≤0.639	≤0.571	≤0.620	≤0.540	≤0.639	≤0.490	
Water Cooled, Electrically Operated, Centrifugal	≤150 tons	kW/ton	≤0.703	≤0.669	≤0.634	≤0.596	≤0.639	≤0.450	
	≥150 tons and ≤300 tons	kW/ton	≤0.634	≤0.596	≤0.634	≤0.596	≤0.639	≤0.450	
	≥300 tons and ≤600 tons	kW/ton	≤0.576	≤0.549	≤0.576	≤0.549	≤0.600	≤0.400	
	≥600 tons	kW/ton	≤0.576	≤0.549	≤0.570	≤0.539	≤0.590	≤0.400	
Air Cooled Absorption Single Effect	All Capacities	COP	≥0.600	NR[e]	≥0.600	NR[e]	NA[d]	NA[d]	ARI 560
Water-Cooled Absorption Single Effect	All Capacities	COP	≥0.700	NR[e]	≥0.700	NR[e]	NA[d]	NA[d]	
Absorption Double Effect Indirect-Fired	All Capacities	COP	≥1.000	≥1.050	≥1.000	≥1.050	NA[d]	NA[d]	
Absorption Double Effect Direct-Fired	All Capacities	COP	≥1.000	≥1.000	≥1.000	≥1.000	NA[d]	NA[d]	

a. The chiller equipment requirements do not apply for chillers used in low-temperature applications where the design leaving fluid temperature is < 40°F.
b. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
c. Compliance with this standard can be obtained by meeting the minimum requirements of Path A or Path B. However, both the full load and IPLV must be met to fulfill the requirements of Path A or Path B.
d. *NA* means that this requirement is not applicable and cannot be used for compliance.
e. *NR* means that there are no minimum requirements for this category.

Figure 24: Water Chilling Packages—Efficiency Requirements

Addendum n: Variable-air-volume fan control is currently required in the standard for multiple-zone systems. This proposal extends these requirements for large single-zone units. Important aspects of this proposal include the following:
• It applies to both unitary (packaged) equipment and chilled water air-handling units.
• It only applies to units with a cooling capacity greater than or equal to 110,000 Btu/h.
• The proposal can be met using either two-speed motors or variable-speed drives on the supply fan(s).
• The minimum speed requirement is set at 67% fan speed.
• It does not take effect until 1/1/2012.
This proposal has achieved industry consensus through discussions with AHRI's Large Unitary Engineering (ULE) Group. Three of the criteria were critical to achieving that consensus:
• The lower threshold of 10 tons for unitary equipment,
• The 2/3 minimum threshold for fan speed, and
• The delay in implementation to 2012.
The significance of the two-thirds minimum speed threshold is to prevent coil frosting on DX coils (particularly for those units that are face split). The reasoning behind the delay in implementation to 2012 is to allow the AC unit manufacturers time to redesign and test their AC units. All of the manufacturers are currently redesigning their lines to meet the 2010 phase-out of certain refrigerants (R-22). Some have already completed this work for certain product lines. The volume of units being tested for refrigerant change outs is straining the available certified testing resources.
Although this requirement does not take effect until 2012, it is believed that manufacturers will begin introducing variable-volume signal-one units in advance of that date. Utility rebate programs, LEED certification, and other incentives should encourage wider demand for these units and will help this requirement to see real savings in advance of the 2012 date.
It should be noted that a second proposal is forthcoming to address the budget systems in the Energy Cost Budget Method (see Table 11.3.2A) to make the budget systems 5, 6, 7, 9, and 11 consistent with the requirements of this proposal.

6.3.2 Criteria. HVAC system must meet ALL of the following criteria:
a. The system serves a single HVAC zone.
b. The equipment must meet the variable flow requirements of Section 6.4.3.10
c. Cooling (if any) shall be provided by a unitary packaged

6.4.3.10 Single Zone Variable-Air-Volume Controls. HVAC systems shall have variable airflow controls as follows:
a. Effective January 1, 2010, air-handling and fan-coil units with chilled-water cooling coils and supply fans with motors greater than or equal to 5 hp shall have their supply fans controlled by two-speed motors or variable speed drives. At cooling demands less than or equal to 50%, the supply fan controls shall be able to reduce the airflow to no greater than the larger of the following:
  1. One half of the full fan speed, or
  2. The volume of outdoor air required to meet the ventilation requirements of Standard 62.1.
b. Effective January 1, 2012, all air-conditioning equipment and air-handling units with direct expansion cooling and a cooling capacity at ARI conditions greater than or equal to 110,000 Btu/h that serve single zones shall have their supply fans controlled by two-speed motors or variable speed drives. At cooling demands less than or equal to 50%, the supply fan controls shall be able to reduce the airflow to no greater than the larger of the following:
  1. Two-thirds of the full fan speed, or
  2. The volume of outdoor air required to meet the ventilation requirements of Standard 62.1.
Include new item b in Section 6.3.2 as follows. Renumber subsequent section items as appropriate (SI units).
6.3.2 Criteria. HVAC system must meet ALL of the following criteria:
a. The system serves a single HVAC zone.
b. The equipment must meet the variable flow requirements of Section 6.4.3.10
c. Cooling (if any) shall be provided by a unitary packaged

Addendum p: This addendum is the second phase of correcting the fan power limitation deficiencies of Standard 90.1-2004. The first phase was corrected by Addendum ac to the 2004 standard, which has been approved and is included in Standard 90.1- 2007. That addendum addressed all fan systems with exception of those systems serving fume hoods. The reason for excluding fume hood systems was to allow Addendum ac to proceed, correcting a majority of the problems, and be included in the 2007 edition of Standard 90.1. This allowed time to assemble a lab working group that could properly address the needs of laboratory exhaust systems. This working group consisted of three individuals from Labs 21, three design engineers, and one person from the ECB subcommittee.
This addendum provides the necessary pressure credits for laboratory exhaust systems that allow prescriptive compliance of these systems.

Exceptions to 6.5.3.1.1:
a. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust and/or return to maintain space pressure relationships necessary for occupant health and safety or environmental control may use variable-volume fan power limitation.
b. Individual exhaust fans with motor nameplate horsepower of 1 hp or less.

TABLE 6.5.3.1.1B Fan Power Limitation Pressure Drop Adjustment

Device	Adjustment
Credits	
Fully ducted return and/or exhaust air systems	0.5 in. w.c. (2.15 in. w.c. for laboratory and vivarium systems)
Return and/or exhaust airflow control devices	0.5 in. w.c.
Exhaust filters, scrubbers, or other exhaust treatment	The pressure drop of device calculated at fan system design condition
Particulate Filtration Credit: MERV 9 through 12	0.5 in. w.c.
Particulate Filtration Credit: MERV 13 through 15	0.9 in. w.c.
Particulate Filtration Credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2× clean filter pressure drop at fan system design condition
Carbon and other gas-phase air cleaners	Clean filter pressure drop at fan system design condition
Heat recovery device, biosafety cabinet	Pressure drop of device at fan system design condition
Evaporative humidifier/cooler in series with another cooling coil	Pressure drop of device at fan system design condition
Sound Attenuation Section	0.15 in. w.c.
Exhaust system serving fume hoods	0.35 in. w.c.
Laboratory and vivarium exhaust systems in high-rise buildings	0.25 in. w.c./100 ft of vertical duct exceeding 75 ft
~~**Deductions**~~	
~~Fume Hood Exhaust Exception (required if 6.5.3.1.1 Exception [c] is taken)~~	~~–1.0 in. w.c.~~

Figure 25: Fan Power Limitation Pressure Drop Adjustment

Addendum s: In Summer 2005, ASHRAE approved addendum g to ASHRAE/IESNA Standard 90.1-2004, which increased the minimum energy efficiency standards of commercial air-cooled air conditioners and heat pumps greater than 65,000 Btu/h. EER and COP (at 47°F) were amended, with new levels taking effect on January 1, 2010. However, IPLV and COP at 17°F were left unchanged.
This addendum updates the COP at 17°F efficiency levels for commercial heat pumps and introduces a new part-load energy efficiency descriptor for all commercial unitary products above 65,000 Btu/h of cooling capacity. The new descriptor, Integrated Energy Efficiency Ratio (IEER), is a replacement for IPLV. The IEER is a significant improvement over IPLV as it allows for uniform rating of all products including single- and multi-stage units. It is based on a weighted average of performance at 100%, 75%, 50%, and 25% of capacity. The new part-load metric is expected to more accurately rate the part-load performance of commercial unitary equipment.
The IEER and COP at 17°F levels in Tables 6.8.1A (Figure 26) and 6.8.1B (Figure 27) were derived based on the expected performance of commercial unitary products meeting the new full-load EER and COP at 47°F requirements that will take effect on January 1, 2010. In addition, IEER values are now for product

classes with cooling capacities between 65,000 and 240,000 Btu/h, which previously had no IPLV minimums.

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Air Conditioners, Air Cooled	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.3 EER (before 1/1/2010) 11.2 EER (as of 1/1/2010) 11.4 IEER (as of 1/1/2010)	ARI 340/360
		All other	Split System and Single Package	10.1 EER (before 1/1/2010) 11.0 EER (as of 1/1/2010) 11.2 IEER (as of 1/1/2010)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER (before 1/1/2010) 11.0 EER (as of 1/1/2010) 11.2 IEER (as of 1/1/2010)	
		All other	Split System and Single Package	9.5 EER (before 1/1/2010) 10.8 EER (as of 1/1/2010) 11.0 IEER (as of 1/1/2010)	
	≥240,000 Btu/h and <760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.5 EER (before 1/1/2010) 10.0 EER (as of 1/1/2010) 9.7 IPLV (before 1/1/2010) 10.1 IEER (as of 1/1/2010)	
		All other	Split System and Single Package	9.3 EER (before 1/1/2010) 9.8 EER (as of 1/1/2010) 9.5 IPLV (before 1/1/2010) 9.9 IEER (as of 1/1/2010)	
	≥760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.2 EER (before 1/1/2010) 9.7 EER (as of 1/1/2010) 9.4 IPLV (before 1/1/2010) 9.8 IEER (as of 1/1/2010)	
		All other	Split System and Single Package	9.0 EER (before 1/1/2010) 9.5 EER (as of 1/1/2010) 9.2 IPLV (before 1/1/2010) 9.6 IEER (as of 1/1/2010)	
Air Conditioners, Water and Evaporatively Cooled	<65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER (as of 1/1/2010)	ARI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER 11.7 IEER (as of 1/1/2010)	ARI 340/360
		All other	Split System and Single Package	11.3 EER 11.5 IEER (as of 1/1/2010)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER (as of 1/1/2010)	
		All other	Split System and Single Package	10.8 EER 11.0 IEER (as of 1/1/2010)	
	≥240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 10.3 IPLV (before 1/1/2010) 11.1 IEER (as of 1/1/2010)	
		All other	Split System and Single Package	10.8 EER 10.1 IPLV (before 1/1/2010) 10.9 IEER (as of 1/1/2010)	

The remainder of the table is left unchanged.

Figure 26: Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps—Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Air Cooled (Cooling Mode)	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.1 EER (before 1/1/2010) 11.0 EER (as of 1/1/2010) 11.2 IEER (as of 1/1/2010)	ARI 340/360
		All other	Split System and Single Package	9.9 EER (before 1/1/2010) 10.8 EER (as of 1/1/2010) 11.0 IEER (as of 1/1/2010)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.3 EER (before 1/1/2010) 10.6 EER (as of 1/1/2010) 10.7 IEER (as of 1/1/2010)	
		All other	Split System and Single Package	9.1 EER (before 1/1/2010) 10.4 EER (as of 1/1/2010) 10.5 IEER (as of 1/1/2010)	
	≥240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.0 EER (before 1/1/2010) 9.5 EER (as of 1/1/2010) 9.2 IPLV (before 1/1/2010) 9.6 IEER (as of 1/1/2010)	
		All other	Split System and Single Package	8.8 EER (before 1/1/2010) 9.3 EER (as of 1/1/2010) 9.0 IPLV (before 1/1/2010) 9.4 IEER (as of 1/1/2010)	
Air Cooled (Heating Mode)	≥65,000 Btu/h and <135,000 Btu/h (Cooling Capacity)	–	47°F db/43°F wb Outdoor Air	3.2 COP (before 1/1/2010) 3.3 COP (as of 1/1/2010)	ARI 340/360
			17°F db/15°F wb Outdoor Air	2.2 COP (before 1/1/2010) 2.25 COP (as of 1/1/2010)	
	≥135,000 Btu/h (Cooling Capacity)	–	47°F db/43°F wb Outdoor Air	3.1 COP (before 1/1/2010) 3.2 COP (as of 1/1/2010)	
			17°F db/15°F wb Outdoor Air	2.0 COP (before 1/1/2010) 2.05 COP (as of 1/1/2010)	

The remainder of the table is left unchanged.

Add the following in Section 3.2, just above IPLV:

integrated energy efficiency ratio (IEER): a single-number figure of merit expressing cooling part-load EER efficiency for commercial unitary air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

Modify the normative reference in Section 12 (under Air Conditioning and Refrigeration Institute) as follows:

Reference	Title
ARI 340/360-20047	Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment

Revise the Standard as follows (SI units).

Figure 27: Electrically Operated Unitary and Applied Heat Pumps—Minimum Efficiency Requirements

Addendum t: ASHRAE/IESNA Standard 90.1 established a product class for “replacement” packaged terminal equipment to distinguish products intended to replace existing equipment in existing constructions with nonstandard external wall openings from products intended for existing and new construction with standard wall openings (16 in. high × 42 in. wide). However, the term “replacement” has been misinterpreted to mean any packaged terminal equipment intended as a replacement unit regardless of the exterior wall openings it must fit in. Conversely, the term “new construction” has been interpreted as meaning a product intended for new constructions only, while in fact it applies equally to existing and new buildings with standard wall openings.

This addendum removes the terms “replacement” and “new construction” from the product classes listed in Table 6.8.1D (Figure 28) and replaces them with the terms “nonstandard size” and “standard size,” respectively, to clarify that one product class is intended for applications with nonstandard size exterior wall openings while the other is intended for applications with standard size exterior wall openings. The addendum also amends Section 6.4.1.5.2 and footnote b to Table 6.8.1D (Figure 28) to clarify that nonstandard size packaged terminal equipment have sleeves with an external wall opening less than 16 in. high or less than 42 in. wide to reflect existing applications where the wall opening is not necessarily less than 16 in. high and less than 42 in. wide. However, to avoid a potential abuse of the definition, nonstandard size packaged terminal equipment are required to have a cross-sectional area of the sleeves less than 670 in.2 (less than 16 × 42 in.).

6.4.1.5.2 Packaged Terminal Air Conditioners. Nonstandard size packaged terminal air conditioners and heat pumps with existing sleeves having an external wall opening of less than 16 in. high or less than 42 in. wide and having a cross-sectional area less than 670 in.2 shall be factory labeled as follows: Manufactured for nonstandard size applications only: not to be installed in new construction projects.

TABLE 6.8.1D Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single -Package Vertical Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps–Minimum Efficiency Requirements

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
PTAC (Cooling Mode) ~~New Construction~~ Standard Size	All Capacities	35.0°C db Outdoor air	$3.66 - (0.213 \times Cap/1000)^{c}$ COP_C	
PTAC (Cooling Mode) ~~Replacements~~ Nonstandard Size[b]	All Capacities	35.0°C db Outdoor air	$3.19 - (0.213 \times Cap/1000)^{c}$ COP_C	
PTHP (Cooling Mode) ~~New Construction~~ Standard Size	All Capacities	35.0°C db Outdoor air	$3.60 - (0.213 \times Cap/1000)^{c}$ COP_C	
PTHP (Cooling Mode) ~~Replacements~~ Nonstandard Size[b]	All Capacities	35.0°C db Outdoor air	$3.16 - (0.213 \times Cap/1000)^{c}$ COP_C	ARI 310/380
PTHP (Heating Mode) ~~New Construction~~ Standard Size	All Capacities		$3.2 - (0.026 \times Cap/1000)^{c}$ COP_H	
PTHP (Heating Mode) ~~Replacements~~ Nonstandard Size[b]	All Capacities		$2.9 - (0.026 \times Cap/1000)^{c}$ COP_H	

The remainder of the table is left unchanged.

Revise footnote b of Table 6.8.1D as follows:

b ~~Replacement~~ Nonstandard size units must be factory labeled as follows: “MANUFACTURED FOR ~~REPLACEMENT~~ NONSTANDARD SIZE APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS.” ~~Replacement~~ Nonstandard size efficiencies apply only to units being installed in ~~with~~ existing sleeves having an external wall opening of less than 0.4 m high ~~and~~ or less than 1.0 m wide and having a cross-sectional area less than 0.4 m^2.

Figure 28: Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps-Minimum Efficiency Requirements

Addendum u: Axial fan open-circuit cooling towers use approximately 50% of the energy consumed by centrifugal fan open-circuit cooling towers. Substantial energy can be saved by requiring centrifugal fan units over 1,100 US gpm at the rating conditions to meet the energy efficiency requirements for axial fan units found in Table 6.8.1G (Figure 23). These requirements are 38.0 gpm/ hp for axial versus 20.0 gpm/hp for centrifugal, rated at 95°F entering, 85°F leaving, and 75°F entering wet-bulb temperature. This would encourage the current market trend towards lower energy axial fan designs. Exceptions are allowed for sound control and ducted installations (which might be used to reduce the potential for freezing in cold climates). Like-for-like replacements on existing buildings that would require extensive rework of the site (such as to the supporting steel) are permitted under Section 6.1.1.3, Exception b.

6.5.5.3 Limitation on Centrifugal Fan Open-Circuit Cooling Towers. Centrifugal fan open-circuit cooling towers
with a combined rated capacity of 1,100 gpm or greater at 95°F condenser water return, 85°F condenser water supply, and 75°F outdoor air wet-bulb temperature shall meet the energy efficiency requirement for axial fan open-circuit cooling towers listed in Table 6.8.1G (Figure 23).
Exception: Open-circuit cooling towers that are ducted (inlet or discharge) or require external sound attenuation.

Addendum y: A product class for heat pump pool heaters was first established in 2002 and was included in the 2004 version of ASHRAE 90.1. At that time, the minimum coefficient of performance (COP) was based on the test methods and rating conditions contained in ASHRAE Standard 146-1998. The rating conditions in Standard 146 used to rate heat pump pool heaters relied on an outdoor temperature of 80°F and an entering water temperature of 80°F.

Since then, the Air-Conditioning, Heating and Refrigeration Institute (AHRI) published ARI standard 1160 "Performance Rating of Heat Pump Pool Heaters," which establishes testing and rating requirements for heat-pump pool heaters. The standard makes reference to ASHRAE 146 for the test methods and provides standard rating conditions at high (80°F) and low (50°F) outdoor temperatures (the entering water temperature being at 80°F). In addition, AHRI has launched a third-party certification program to independently verify the performance ratings (heating capacity and coefficient of performance) of heat pump pool heaters claimed by manufacturers based on ARI 1160.

This proposal establishes ARI 1160 as the test procedure for heat-pump pool heaters and requires that the minimum coefficient of performance (COP) of 4 be met at the low outdoor temperature of 50°F (instead of the high outdoor temperature of 80°F currently required). These proposed changes significantly increase the stringency of ASHRAE Standard 90.1, as heat pump pool heaters will now be required to deliver a COP of 4 at a higher temperature lift.

TABLE 7.8 Performance Requirements for Water Heating Equipment

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
Heat pump pool heaters	All	50.0°F [10.0°C] db 44.2°F [6.78°C] wb Outdoor air 80.0°F [26.7°C] Entering Water	4.0 COP	~~ASHRAE 146~~ ARI 1160

Remainder of table unchanged.

Add reference in Chapter 12 and modify as follows: (I-P and SI units).

Reference	Title
~~**Air Conditioning and Refrigeration Institute,**~~ **Air Conditioning, Heating and Refrigeration Institute** **4100 North Fairfax Drive, Suite 200, Arlington, VA 22203**	
ARI 1160-2008	Performance Rating of Heat Pump Pool Heaters

Figure 29: Performance Requirements for Water Heating Equipment

Addendum ad: Liquid-to-liquid heat exchangers are critical system components used in many buildings covered by ASHRAE Standard 90.1. Applications include, but are not limited to, free cooling with cooling towers, pressure interceptor, water-source heat pump loops, and heat recovery. The proper functioning of these heat exchangers helps to ensure that the energy efficiency of other certified equipment, such as chillers and cooling towers, is fully achieved.

A relatively new certification program for ARI Standard 400 is now being widely adopted by this industry. This certification program provides a sound engineering basis for rating the performance of liquid-to-liquid heat exchangers. Inclusion of certification requirements for this equipment will benefit both manufacturers and consumers, allow product comparisons, and provide incentives to manufacturers to improve heat exchanger efficiency in order to gain market share. This program also complements the recently adopted certification requirements for closed-circuit cooling towers (Addendum l to Standard 90.1-2007).
As these devices function to efficiently transfer heat between two fluids, no efficiency requirements are listed. Additionally, the cost for the ARI 400 certification program is similar to other ARI Certification Programs, involving thermal tests and the ARI program cost.

Lastly, the original Section 6.4.1.4f, addressing Table 6.8.1G (Figure 23) must be deleted based on Addendum ak to Standard 90.1-2004, as requirements for CTI certification were added back in to Table 6.8.1G (Figure 23) with that addendum, negating the original paragraph.

TABLE 6.8.1K Heat Transfer Equipment

Equipment Type	Subcategory	Minimum Efficiency*	Test Procedure†
Liquid-to-liquid heat exchangers	Plate type	NR	ARI 400

* NR = No Requirement
† Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

Figure 30: Heat Transfer Equipment

6.4.1.4 Verification of Equipment Efficiencies. Equipment efficiency information supplied by manufacturers shall be verified as follows:
a. Equipment covered under EPACT shall comply with U.S. Department of Energy certification requirements.
b. If a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, then the product shall be listed in the certification program, or
c. if a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, but the product is not listed in the existing certification program, the ratings shall be verified by an independent laboratory test report, or
d. if no certification program exists for a covered product, the equipment efficiency ratings shall be supported by data furnished by the manufacturer, or
e. where components such as indoor or outdoor coils from different manufacturers are used, the system designer shall specify component efficiencies whose combined efficiency meets the minimum equipment efficiency requirements in Section 6.4.1.
f. Requirements for plate type liquid to liquid heat exchangers are listed in Table 6.8.1K.

5.2.2.3 From the Lighting Subcommittee

Addenda:
Two addendums for the lighting section have been proposed to the ASHRAE 90.1 2007. Addendum i applies a four-zone lighting power density approach to exterior lighting requirements. Addendum aw recognizes the practical design application of excluding bathroom lighting from “master” switch control in hotel/motel guest rooms and adds a requirement to eliminate wasted light in guest room bathrooms.

Addendum i: This proposal will apply a four-zone lighting power density approach to exterior lighting requirements. This approach recognizes the varying lighting needs and design differences associated with different building locations. It is acceptable and prudent to reduce the light levels as the designer leaves the downtown city center entering into mixed commercial/ high-rise residential districts, then enters into residential areas, and then into rural areas. Several organizations, including the IESNA have been working to develop a zonal approach to exterior lighting recommended practice and this change in the standard will follow that guidance.

The specific IESNA documents used in this proposal are RP-20, DG-5, IESNA Handbook, RP-2, G-1 and RP-33. There are some instances where IESNA recommendations in these documents are available for all four zone criteria, but in many cases only three light level recommendations were found and referenced. Other standards use a multizone system to either classify LPD, lumen, or light trespass requirements—California T-24 (4-zone W/sf), the upcoming MOL (5-zone Lumen/sf, and LEED (light trespass). These standards were evaluated and in some cases incorporated into this proposal.

The first change in Section 9.4.5 is the deletion of the 5% additional power allowances, which is replaced by a base wattage allowance per site. The second change to this section is to define the four zones and apply appropriate requirements. The four zones are based on IESNA and other group definitions to match other requirements and guidance expected to be encountered by designers. The majority of building sites will fall into LZ3, LZ2, or LZ1, and the sites that remain in LZ4 will generally be of relatively small sizes. The added "Base Site Allowance" for each zone takes into account that most sites are not rectangular or match the iso-diagram of typical light luminaries.

The associated energy change from this proposal comes from the lower illuminance requirements for primarily zones 1–3, where the majority of buildings are constructed. Numerous point-by-point lighting calculations were performed for parking lots, walkways, stairways, pedestrian tunnels, entries (with and without canopies), sales canopies, service stations, and auto dealerships for the four zones. In the initial calculations for the parking lots, there was a noticeable difficulty in achieving the recommended light level when the space was 20,000 ft2 and lower, without any additional power allowance (this was especially true in zone 4). Six odd shaped parking lots were modeled for all four lighting zones to verify that the requirement would cover varying design needs. This modeling was used to determine appropriate base site allowances. Because of the base site allowance, the actual LPDs are on a sliding scale, as shown below.

The energy savings from this zone approach is shown in the chart below, with total energy used in each lighting zone for the various square footages. The solid line is the current 2004 standard.

Revise the Standard as follows (I-P units):

Changes are presented in the tables below:

9.4.5 Exterior Building Lighting Power. The total exterior lighting power allowance for all exterior building applications is the sum of the base site allowance plus the individual allowances for areas that are designed to be illuminated and are lighting power densities permitted in Table 9.4.65 for the applicable lighting zone for these applications plus an additional unrestricted allowance of 5% of that sum. Trade-offs are allowed only among exterior lighting applications listed in the Table 9.4.65 "Tradable Surfaces" section. The lighting zone for the building exterior is determined from Table 9.4.5 unless otherwise specified by the local jurisdiction.

Exceptions to 9.4.5: Lighting used for the following exterior applications is exempt when equipped with a control device that complies with the requirements of Section 9.4.1.3 and is independent of the control of the nonexempt lighting:

a. Specialized signal, directional, and marker lighting associated with transportation.
b. Advertising signage or directional signage.
c. Lighting integral to equipment or instrumentation and installed by its manufacturer.
d. Lighting for theatrical purposes, including performance, stage, film production, and video production.
e. Lighting for athletic playing areas.
f. Temporary lighting.

g. Lighting for industrial production, material handling, transportation sites, and associated storage areas.
h. Theme elements in theme/amusement parks.
i. Lighting used to highlight features of public monuments and registered historic landmark structures or buildings.

Addendum aw:
This change recognizes the practical design application of excluding bathroom lighting from “master” switch control in hotel/motel guest rooms and adds a requirement to eliminate wasted light in guest room bathrooms. Recent research shows that approximately 80% of the wasted guest room bathroom lighting can be saved with a 60-minute-limit control device. The 60-minute limit also provides ample time for any potential safety or convenience concerns related to bathrooms, such as the lights turning off too early while the bathroom is still occupied. The 5 W allowance for night lights recognizes the practical current design application of guest room bathroom night light use but at a reasonable low level.

9.4.1.4 Additional Control.
g. Hotel and Motel Guest Room Lighting—hotel and motel guest rooms and guest suites shall have a master control device at the main room entry that controls all permanently installed luminaires and switched receptacles.
Guest rooms in hotels, motels, boarding houses, and similar buildings shall have one or more control device(s) at the entry door that collectively control all permanently installed luminaires and switched receptacles, except those in the bathroom(s). Suites shall have control(s) meeting these requirements at the entry to each room or at the primary entry to the suite. Bathrooms shall have a control device installed to automatically turn off the bathroom lighting, except for night lighting not exceeding 5 W, within 60 minutes of the occupant leaving the space.

Addendums out for public review:
"by" LPDs
"dd" Toplighting change to 900 sqft
"dc" remove Tandem wiring
"cz" Parking garage control + exception
"cu" Nighttime emergency lighting control
"ct" daylighting change to 250 sqft
"cs" receptacle control refinements
"cn" advanced lighting control
"cf" stairway lighting control
"ce" multi-level control
"cd" exterior control
"bz" electrical monitoring
"cx" 40% allowance - Working group is formed and meeting

5.2.2.4 From the ECB Subcommittee

Addendum w modifies requirements on exhaust air energy recovery for multifamily buildings in Appendix G and addendum r converts appendix G into a normative section. Addendums k and l proposed by the mechanical subcommittee do not prompt a change in section 11 or section G but addenda m, n and o do.

Addenda:
Addendum r: This addendum changes Informative Appendix G Performance Rating Method into a Normative Appendix. Additionally, some language has been modified to make the Appendix Enforceable.
Addendum w: This addendum contains two changes. The first change to the footnote of Table G3.1.1A (Figure 31) is to make it clear that Exception a to Section G3.1.1 also applies here. The second change is to the exception to G3.1.2.10 on Exhaust Air Energy Recovery for multifamily buildings because they are unlikely to have a centralized exhaust air system needed to effectively recover heat.

TABLE G3.1.1A *Baseline* HVAC System Types

Building Type	Fossil Fuel, Fossil/Electric Hybrid, and Purchased Heat	Electric and Other
Residential	System 1 – PTAC	System 2 – PTHP
Nonresidential & 3 Floors or Less & <25,000 ft^2	System 3 – PSZ-AC	System 4 – PSZ-HP
Nonresidential & 4 or 5 Floors & <25,000 ft^2 or	System 5 – Packaged	System 6 – Packaged VAV w/PFP
5 Floors or Less & 25,000 ft2to 150,000 ft^2	VAV w/ Reheat	Boxes
Nonresidential & More than 5 Floors or	System 7 – VAV	System 8 – VAV
>150,000 ft^2	w/Reheat	w/PFP Boxes

Notes:
Residential building types include dormitory, hotel, motel, and multifamily. Residential space types include guest rooms, living quarters, private living space, and sleeping quarters. Other building and space types are considered nonresidential.
Where no heating system is to be provided or no heating energy source is specified, use the "Electric and Other" heating source classification.
Where attributes make a building eligible for more than one *baseline* system type, use the predominant condition to determine the system type for the entire building except as noted in Exception a to Section G3.1.1.
For laboratory spaces with a minimum of 5000 cfm of exhaust, use systems type 5 or 7 and reduce the exhaust and makeup air volume to 50% of design values during unoccupied periods. For all electric buildings the heating shall be Electric Resistance.

Figure 31: *Baseline* HVAC System Types

Add Exception i to the Exceptions to Section G3.1.2.10 as follows:

G3.1.2.10 Exhaust Air Energy Recovery
Exceptions: If any of these exceptions apply, exhaust air energy recovery shall not be included in the baseline building design…..
i. Systems serving dwelling units in multifamily buildings.

General discussion and requests for interpretation:

Revising Table G3.1.1A (Figure 31**):** A revision to table G3.1.1A (Figure 31) is proposed. Separate baselines are proposed for residential, healthcare and use of packaged systems instead of chilled water baselines for low-rise office buildings. Also, guidelines are proposed for what is acceptable by the industry for the baseline. For small multifamily - DX with gas heat was proposed as a baseline. For large multifamily – a water source heat pump with fluid cooler was proposed as the baseline. NYSERTA guideline for multifamily as a potential to generate baselines for multifamily buildings was proposed. Existing HVAC equipment that is not replaced or modified should be modeled as it exists in both the proposed and baseline buildings, resulting in neither a credit nor a penalty. With regard to Section G3.1.1 and Tables G3.1.1A (Figure 31) and G3.1.1B, the current approach is sufficient for Sports Arenas, with the exception of specific spaces for summer-season venues.

The enclosed restrooms, storage, concession or other building support areas adjacent or within open concourses for summer-season venues are generally heating only and so not applicable to the current standard base systems. The ECB Subcommittee recent development of the Heating Only System (System 10 and 11) appears to provide a solution for these areas, and thus could be used for the exception described in G3.1.1b.

The other consideration for Appendix G and sports arenas would be related to envelope insulation values. For summer-season venues, standard-level insulation likely has a poor cost-benefit ratio compared to reduced insulation levels, for enclosed spaces adjacent to the open concourses.

Unmet load hours: It was discussed that the throttling range is required to be simulated to match the design and be kept constant between the proposed and baseline model. An unmet load is redefined to be 2 or more degrees outside of temperature set point. It should also be clear that two zones out of set point during one hour is equivalent to one unmet load hour. It is proposed to eliminate the 50 hour maximum differential of unmet load hours between proposed and baseline. The understanding is that it's a lot of work, but does not generally lead to improvements in the accuracy of the model. Also, the maximum permissible hours unmet should be defined by number of hours instead of a %. While it is difficult for buildings with a large number of zones to comply, it is possible.

Temperature control throttling range: The number of degrees that room temperature must change in order to go from full heating to no heating or from full cooling to no cooling.

Unmet load hour: an hour in which one or more zones is two or more degrees outside of the thermostat setpoint range. If more than one zone is two or more degrees outside of thermostat setpoint range during the same hour that is considered one unmet load hour.

Ventilation language update: Changes were proposed to Section G3.1.2.5 on ventilation. The section will now read as:
G3.1.2.5 Ventilation. Minimum ventilation system outdoor air intake flow, defined as design outdoor airflow required at the ventilation system outdoor air intake, shall be the same for the proposed and baseline building designs.
Exception: One or more of the following exceptions may be applied to earn credit for improved ventilation design and control strategies.
a) When modeling demand-control ventilation in the proposed design when its use is not required by Section 6.4.3.8.
b) When designing non-residential systems in accordance with ASHRAE 62.1 Section 6.2 Ventilation Rate Procedure, reduced ventilation airflow rates may be calculated for each HVAC zone in the proposed design with a zone air distribution effectiveness (Ez) > 1.0 as defined by Table 6-2 in ASHRAE 62.1-2004. Baseline ventilation airflow rates shall be calculated using the proposed design Ventilation Rate Procedure calculation with the following change. No other ventilation rate procedure input variables shall be changed.
Zone air distribution effectiveness shall be changed to 1.0 in each zone having a zone air distribution effectiveness(Ez)>1.0.A detailed summary of both the proposed design and baseline design Ventilation Rate Procedure calculations (ASHRAE 62.1 ventilation spreadsheet tool or equivalent) shall be submitted to the rating authority to claim credit for this exception."

Chiller curves: Development of the chiller curves for use with baseline was discussed.

Transformer sizing: A discussion on transformer sizing concluded that the transformer should be oversized to the same degree in the baseline and proposed. Wait on this because of part load curve issues.

Air-tightness: Guidance for air tightness in the ASHRAE 90.1 code for commercial buildings discussed. Possibly use baseline of 0.4 and proposed as low as 0.25 for only if commissioning and testing is required in the design documents. A minimum value of 0.4 for the baseline value was proposed to be included in chapter 11 and appendix G of the code. A suggestion was made to include an informative appendix in the code for calculating infiltration.

Service Water Heating: Agreed with intent but changed the language. Revised language: "The service hot-water system type in the budget building design shall be identical to the proposed building design. The service hot-water system performance of the budget building design shall meet the requirements of Table 7.8 (Figure 29). Exception (a) If the service hot water system type is not listed in Table 7.8 (Figure 29) it shall be identical to the proposed building design."

On-site renewables: After understanding that it was not clear to the proposer how on-site renewables were treated, the subcommittee agreed to revise the section to add clarity. Two definitions were added and section 11.2.3 was revisited.
On-site renewable energy: Energy derived from renewable sources produced directly at the building site that is used to offset consumption of purchased energy.
Purchased energy: Energy or power purchased for consumption at the building site.
Section 11.2.3 Purchased Energy Rates: Annual energy costs shall be determined using rates for purchased energy, such as electricity, gas, oil, propane, steam and chilled water, and approved by the adopting authority.

Exception: On-site renewable energy sources and/or site recovered energy shall not be considered purchased energy. When these energy sources are not calculated/included directly in the energy simulation their consumption shall be subtracted from the proposed design energy consumption prior to calculating the design energy cost. Where on-site renewable energy or site-recovered energy sources are used, the budget building design shall be based on the energy source used as the backup energy source or electricity if no backup energy source has been specified."

Minimum flow setpoints (systems 5 and 7): Modifications were made to section G3.1.3.13 for VAV Minimum Flow Setpoints exception as modified by previous addendum. The first exception will now read: "Exception (a) Systems serving laboratory spaces shall reduce the makeup air volume during unoccupied periods to the largest of 50% of zone peak air flow, the minimum outdoor air flow rate, or the air flow rate required complying with applicable codes or accreditation standards. The laboratory exhaust fan shall be modeled as constant horsepower reflecting constant volume stack discharge with outside air bypass."

The committee also added a new section G3.1.2.9.1 which states that the calculated system fan power should be distributed to supply, return, exhaust, and relief fans in the same proportion as the proposed design.

5.2.3 Laboratory's TERP Web Site "esl.tamu.edu/terp"

Since the fall of 2001, the Laboratory has maintained a TERP webpage (

Figure 32), where information is provided to builders, code officials, the design community and homeowners about TERP. This information includes:

- E^2calc: Energy & Emissions toolkit
    - Opening page: this page directs the visitor to three choices, including:
        - The eCalc legacy version: This is the emissions calculator that the Laboratory developed for the State of Texas, which contains procedures for calculating NOx, SOx and CO2 emissions calculations from new building models, community projects, and renewables.
        - The kWh-NOx emissions calculator: This is the synchronous NOx emissions calculator for projects where the kWh savings are known for a particular county.
        - The IC3: This is the entry page for the Laboratory's International Code Compliance Calculator, which was developed at the request of several municipalities for calculating code compliance with the 2000/2001 IECC with SEER 13.
        - The TERP Main page: this is the main page for the TERP project
- The TERP Main Page
    - Navigation: this page contains general information about the project.
        - Code Compliance Calculator
        - SB5 reports: this contains the Laboratory's reports to the TCEQ and the Legislature since 2001, as well as conference paper and other presentations about the effort
        - Testimony: The ESL's Legislative testimony
        - About: more general information about the Laboratory's SB5 responsibilities
        - More about TERP
        - Role
        - Links
        - Weather data page: this page is the link to the Laboratory's on-line weather data depository for the hourly/daily weather data gathered as part of the TERP program. This is the main navigation page for find different types of weather data for the 17 sites listed, including:
            - Daily spreadsheet format example
            - Hourly spreadsheet format example
            - Example daily weather data graphs

- Example hourly weather data graphs
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  - Links
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  - Administrator
- Login Form –where users can login to the web site
- Quick Links
  - TERP Stakeholder's Letter
  - ESL Report to SECO on IECC/IRC 2009 Stringency
  - 12/08--Comptroller's Home Energy Efficiency Report
  - IC3 calculator: updated to v3.6.1!
  - Legacy eCalc Energy & Emissions Calculator
- Upcoming conferences
- Past conferences

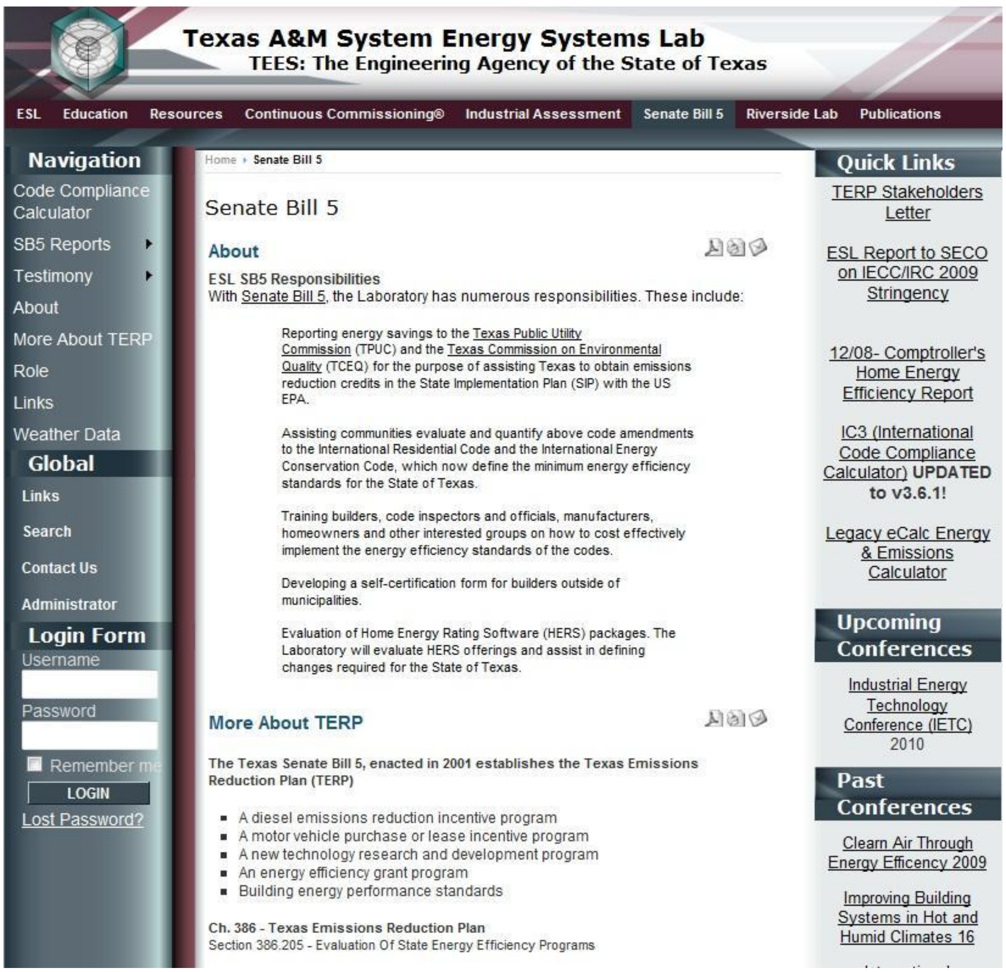


Figure 32: The Laboratory's Senate Bill 5 Web Site (main page)

Figure 33: Opening Page for the Laboratory's eCALC Energy and Emissions Toolkit

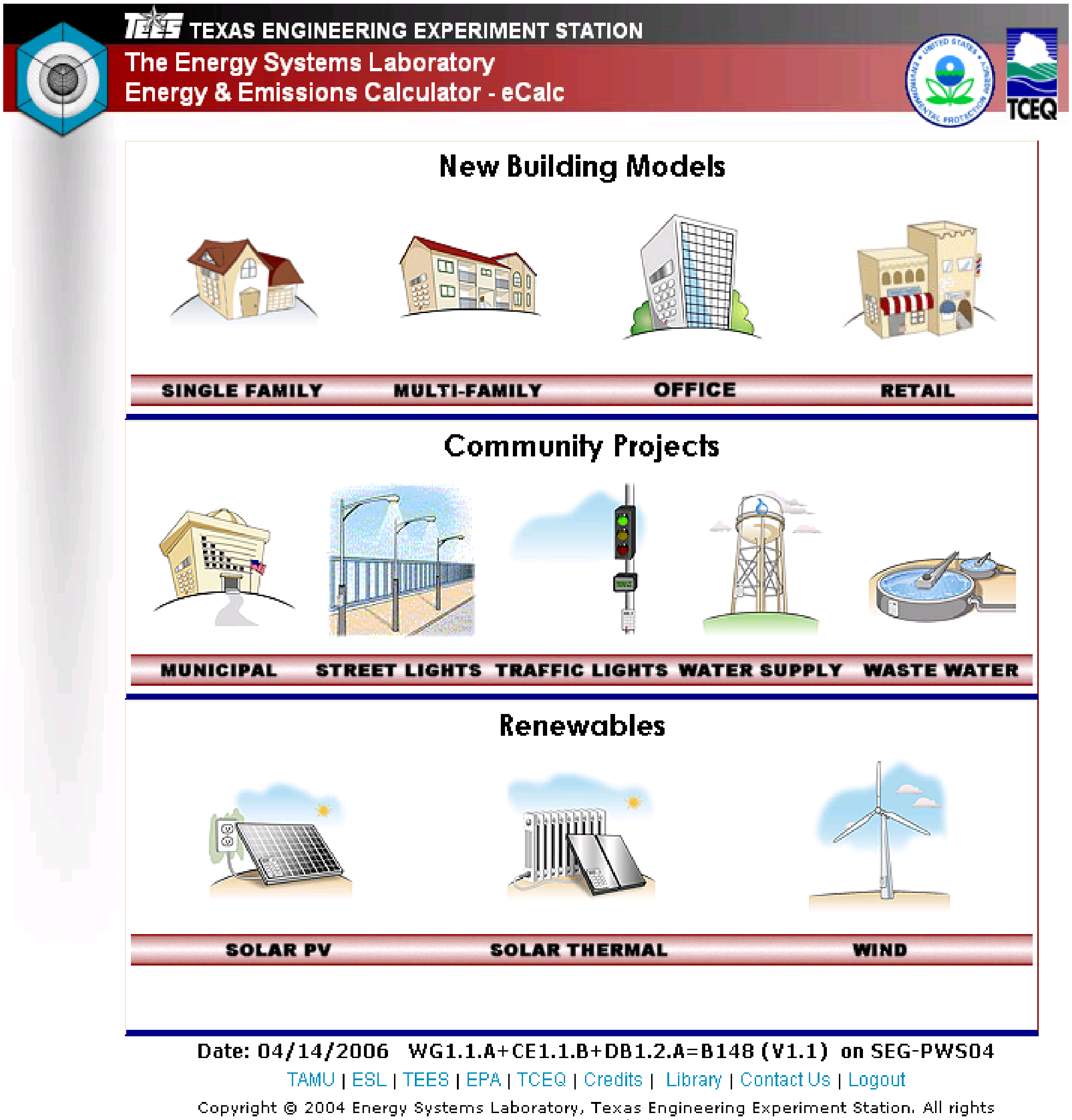
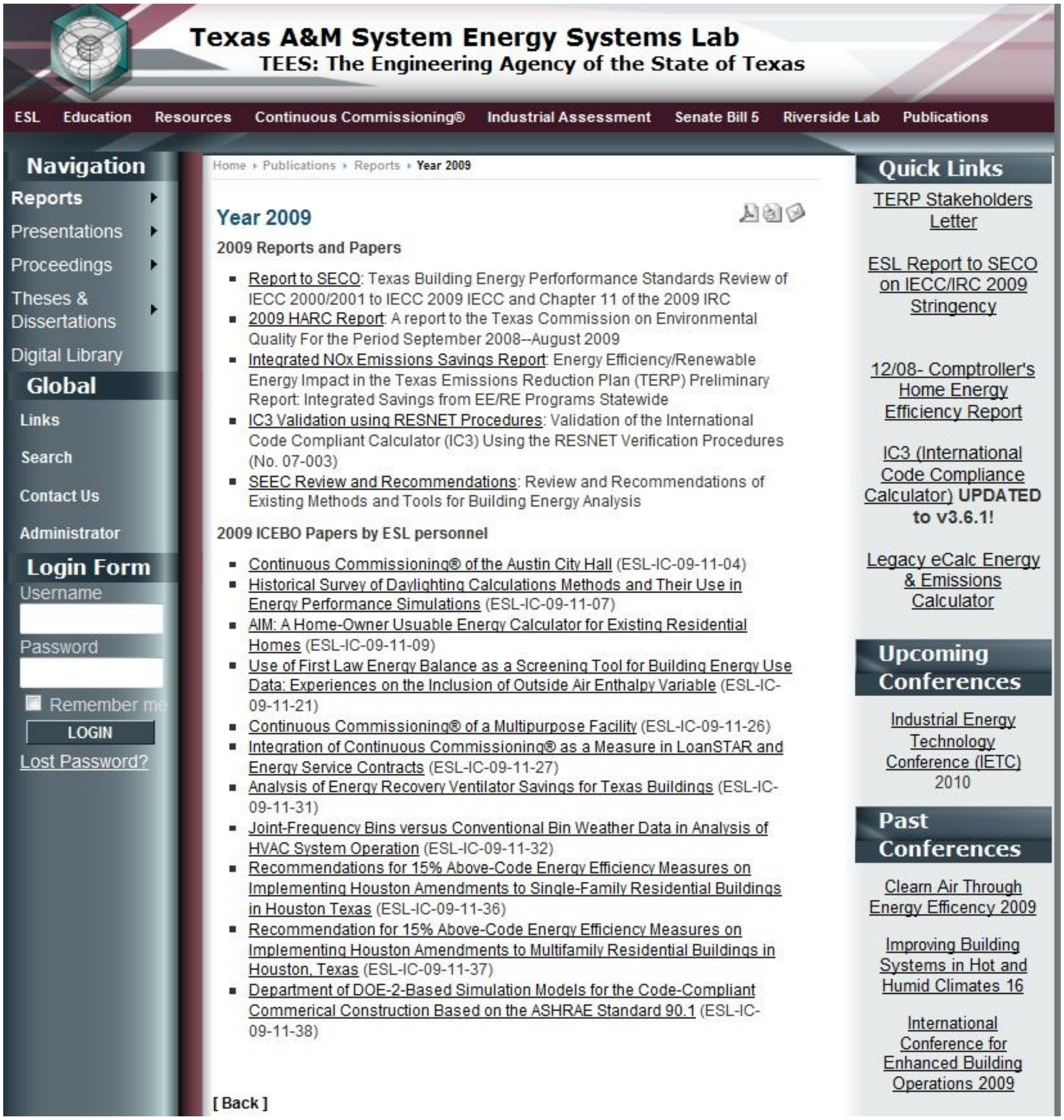


Figure 34: Web Page Providing Access to the Laboratory's eCALC Energy and Emissions Calculator

Figure 35: Web Page Providing Access to the Laboratory's International Code Compliance Calculator (ICCC)



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Year 2009

2009 Reports and Papers

- Report to SECO: Texas Building Energy Perforformance Standards Review of IECC 2000/2001 to IECC 2009 IECC and Chapter 11 of the 2009 IRC
- 2009 HARC Report: A report to the Texas Commission on Environmental Quality For the Period September 2008--August 2009
- Integrated NOx Emissions Savings Report: Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP) Preliminary Report: Integrated Savings from EE/RE Programs Statewide
- IC3 Validation using RESNET Procedures: Validation of the International Code Compliant Calculator (IC3) Using the RESNET Verification Procedures (No. 07-003)
- SEEC Review and Recommendations: Review and Recommendations of Existing Methods and Tools for Building Energy Analysis

2009 ICEBO Papers by ESL personnel

- Continuous Commissioning® of the Austin City Hall (ESL-IC-09-11-04)
- Historical Survey of Daylighting Calculations Methods and Their Use in Energy Performance Simulations (ESL-IC-09-11-07)
- AIM: A Home-Owner Usuable Energy Calculator for Existing Residential Homes (ESL-IC-09-11-09)
- Use of First Law Energy Balance as a Screening Tool for Building Energy Use Data: Experiences on the Inclusion of Outside Air Enthalpy Variable (ESL-IC-09-11-21)
- Continuous Commissioning® of a Multipurpose Facility (ESL-IC-09-11-26)
- Integration of Continuous Commissioning® as a Measure in LoanSTAR and Energy Service Contracts (ESL-IC-09-11-27)
- Analysis of Energy Recovery Ventilator Savings for Texas Buildings (ESL-IC-09-11-31)
- Joint-Frequency Bins versus Conventional Bin Weather Data in Analysis of HVAC System Operation (ESL-IC-09-11-32)
- Recommendations for 15% Above-Code Energy Efficiency Measures on Implementing Houston Amendments to Single-Family Residential Buildings in Houston Texas (ESL-IC-09-11-36)
- Recommendation for 15% Above-Code Energy Efficiency Measures on Implementing Houston Amendments to Multifamily Residential Buildings in Houston, Texas (ESL-IC-09-11-37)
- Department of DOE-2-Based Simulation Models for the Code-Compliant Commerical Construction Based on the ASHRAE Standard 90.1 (ESL-IC-09-11-38)

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Legacy eCalc Energy & Emissions Calculator

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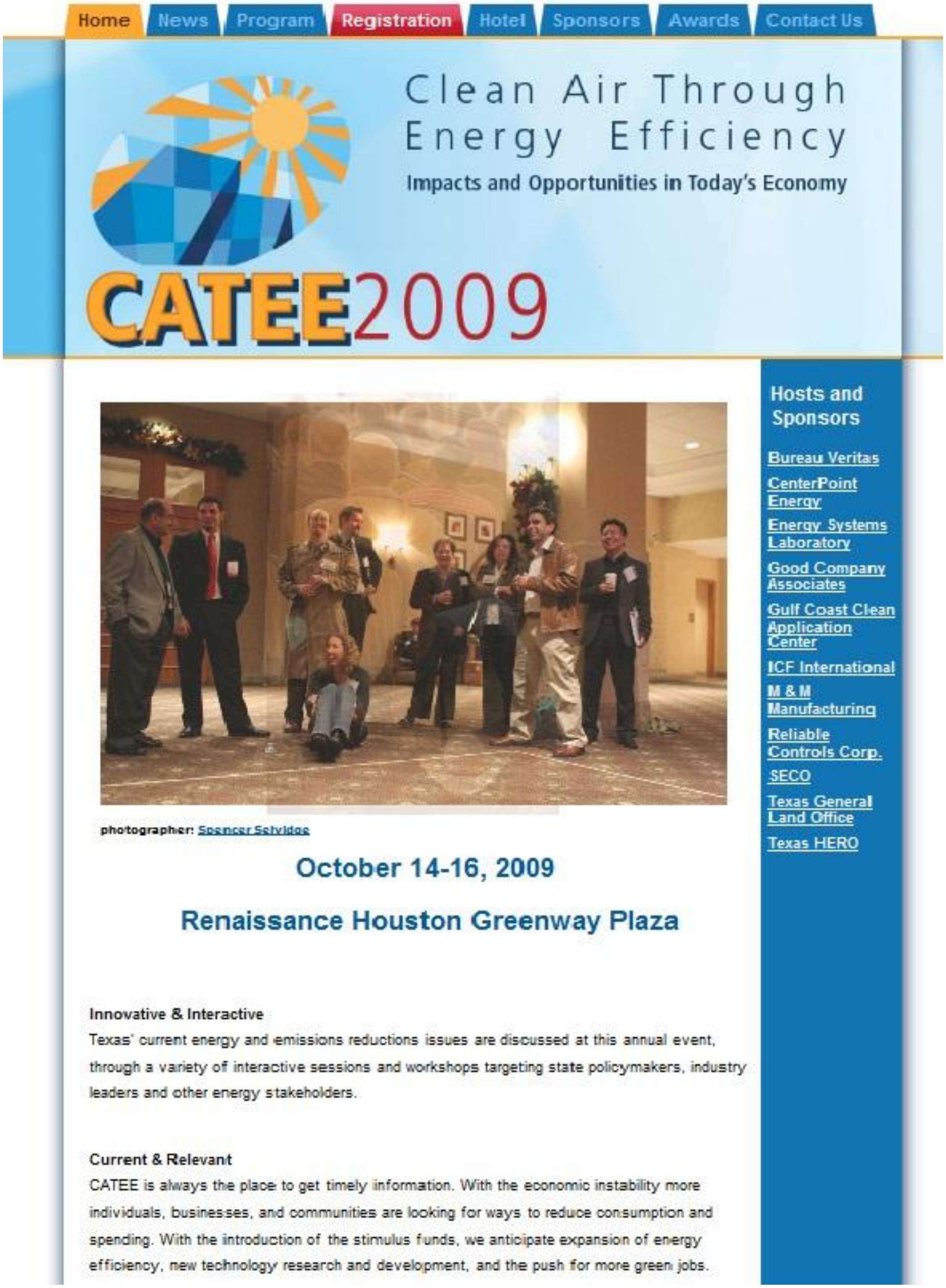
Improving Building Systems in Hot and Humid Climates 16
International Conference for Enhanced Building Operations 2009

Figure 36: SB5 Public opening page for the Laboratory TERP Effort



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Clean Air Through Energy Efficiency

Impacts and Opportunities in Today's Economy

CATEE2009

photographer: Spencer Selvidge

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- Texas HERO

October 14-16, 2009

Renaissance Houston Greenway Plaza

Innovative & Interactive

Texas' current energy and emissions reductions issues are discussed at this annual event, through a variety of interactive sessions and workshops targeting state policymakers, industry leaders and other energy stakeholders.

Current & Relevant

CATEE is always the place to get timely information. With the economic instability more individuals, businesses, and communities are looking for ways to reduce consumption and spending. With the introduction of the stimulus funds, we anticipate expansion of energy efficiency, new technology research and development, and the push for more green jobs.

Figure 37: Web Page Providing Information about the Laboratory's 2008 Clean Air Through Energy Efficiency (CATEE) Conference


9th International Conference for Enhanced Building Operations
Nov. 17-18, 2009 Austin, Texas

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AUSTIN,TEXAS

ICEBO 2009 will take place November 17-18, 2009 in Austin, Texas. The conference will be at the AT&T Conference Center, a LEED-certified building, on the campus of The University of Texas. ICEBO 2009 is hosted by the Energy Systems Laboratory located at Texas A&M University, College Station and co-hosted by Austin Energy. For registration and more detailed information, please visit our website.

The conference will bring together an international group of practitioners and researchers who routinely minimize the energy consumption, operating costs, and environmental impacts of buildings while improving the health and comfort of occupants. ICEBO 2009 is the leading forum for timely exchanges among individuals interested in the continuous improvement and maintenance of buildings, their energy usage and environmental impact. The topics to be discussed are:

- Worldwide best practices in commissioning, retro-commissioning, and Continuous Commissioning® new and existing buildings
- Mission-critical facilities (hospitals, data centers, central utility plants, etc.) operation optimization for best performance and maximum energy savings
- Improved building automation, controls, and sensor accuracy
- Commissioning for Energy Star and LEED® (NC and EB) certifications
- Achieving sustainability, saving energy, and improving occupant comfort
- Planning and designing intelligent buildings'
- On-site renewable energy applications (wind, solar, fuel cell, etc.)
- Measuring and verifying performance of building improvements
- Success stories of combined heat and power (CHP) and distributed generation (DG)
- New federal and state building energy efficiency initiatives
- International markets and collaboration for improving building performance

In addition to the conference, three workshops are being planned – one pre-conference, two post-conference. The pre-conference workshop is a Continuous Commissioning® Workshop, which is a full day. The Measurement & Verification and LEED® workshops (post-conference) are half day workshops.

The international approach of ICEBO makes it unique. The conferences alternate between USA and international sites. ICEBO 2009 will be held in the U.S. in Austin, Texas. Other recent venues include

- ICEBO 2008, Berlin, Germany;
- ICEBO 2007, San Francisco, California;
- ICEBO 2006, Shenzhen, China;
- ICEBO 2005, Pittsburgh, Pennsylvania;
- ICEBO 2004, Paris, France.

The conferences are closely coordinated with the International Energy Agency's annexes on building commissioning.

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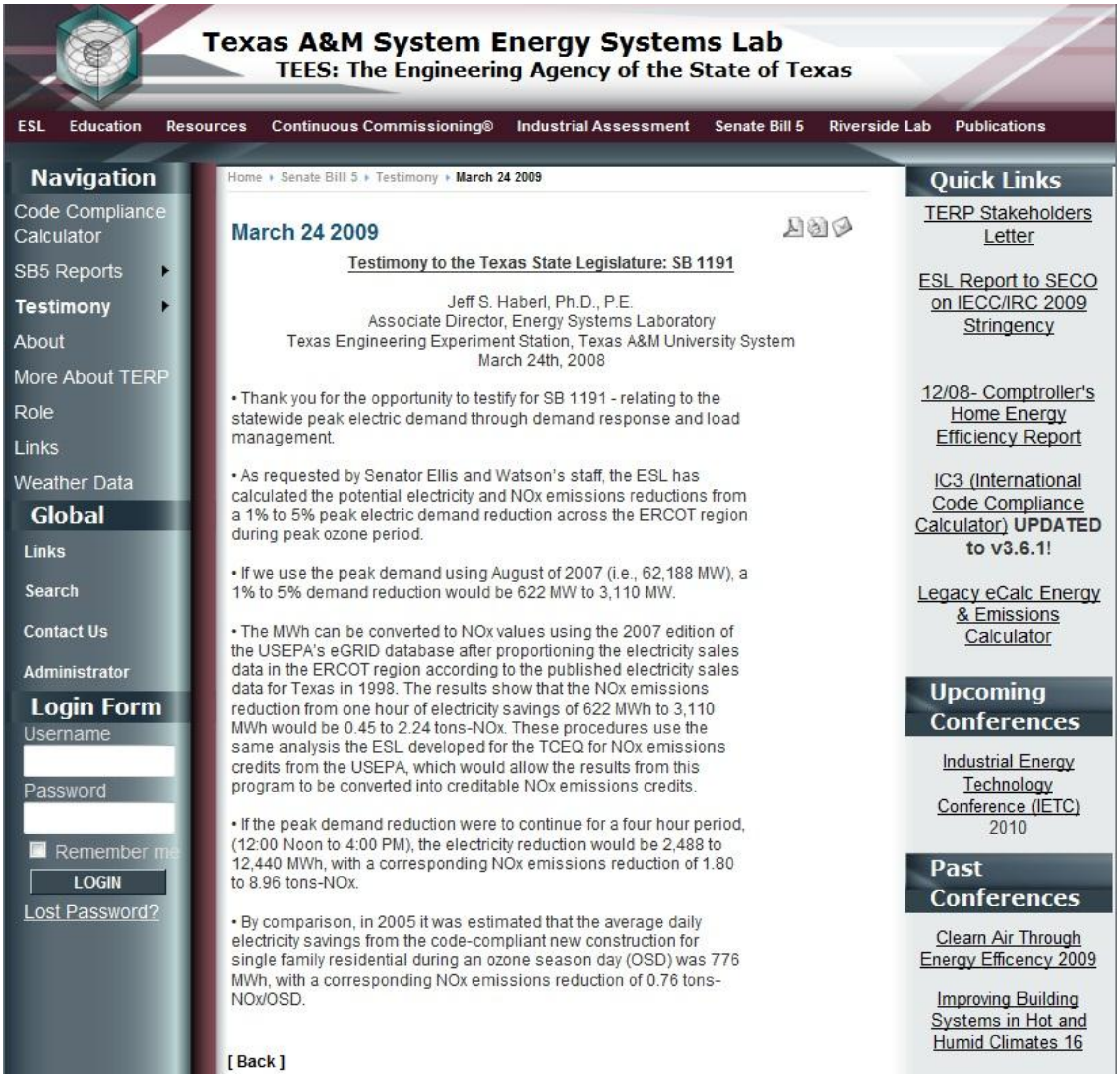
Figure 38: Web Page Providing Information about the Laboratory's 9th International Conference for Enhanced Building Operations (ICEBO) Conference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March 24 2009

Testimony to the Texas State Legislature: SB 1191

Jeff S. Haberl, Ph.D., P.E.
Associate Director, Energy Systems Laboratory
Texas Engineering Experiment Station, Texas A&M University System
March 24th, 2008

• Thank you for the opportunity to testify for SB 1191 - relating to the statewide peak electric demand through demand response and load management.

• As requested by Senator Ellis and Watson's staff, the ESL has calculated the potential electricity and NOx emissions reductions from a 1% to 5% peak electric demand reduction across the ERCOT region during peak ozone period.

• If we use the peak demand using August of 2007 (i.e., 62,188 MW), a 1% to 5% demand reduction would be 622 MW to 3,110 MW.

• The MWh can be converted to NOx values using the 2007 edition of the USEPA's eGRID database after proportioning the electricity sales data in the ERCOT region according to the published electricity sales data for Texas in 1998. The results show that the NOx emissions reduction from one hour of electricity savings of 622 MWh to 3,110 MWh would be 0.45 to 2.24 tons-NOx. These procedures use the same analysis the ESL developed for the TCEQ for NOx emissions credits from the USEPA, which would allow the results from this program to be converted into creditable NOx emissions credits.

• If the peak demand reduction were to continue for a four hour period, (12:00 Noon to 4:00 PM), the electricity reduction would be 2,488 to 12,440 MWh, with a corresponding NOx emissions reduction of 1.80 to 8.96 tons-NOx.

• By comparison, in 2005 it was estimated that the average daily electricity savings from the code-compliant new construction for single family residential during an ozone season day (OSD) was 776 MWh, with a corresponding NOx emissions reduction of 0.76 tons-NOx/OSD.

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Legacy eCalc Energy & Emissions Calculator

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Industrial Energy Technology Conference (IETC) 2010

Past Conferences
Clearn Air Through Energy Efficency 2009
Improving Building Systems in Hot and Humid Climates 16

Figure 39: Web Page Providing Information about the Laboratory's TERP Testimony to the Senate Natural Resources Committee

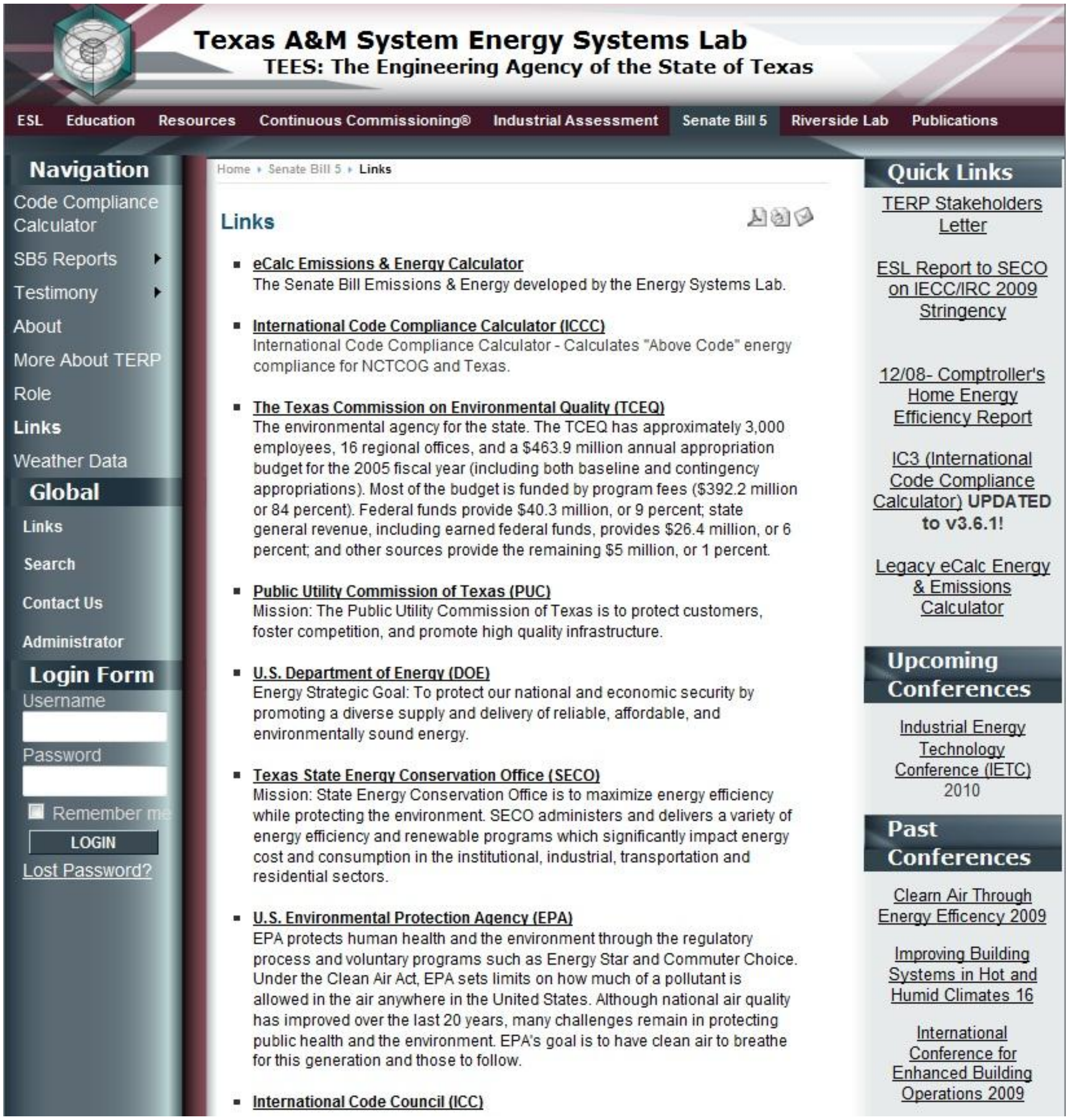


Figure 40: Web Page Providing Information about the Laboratory's Links to Other Government Agencies

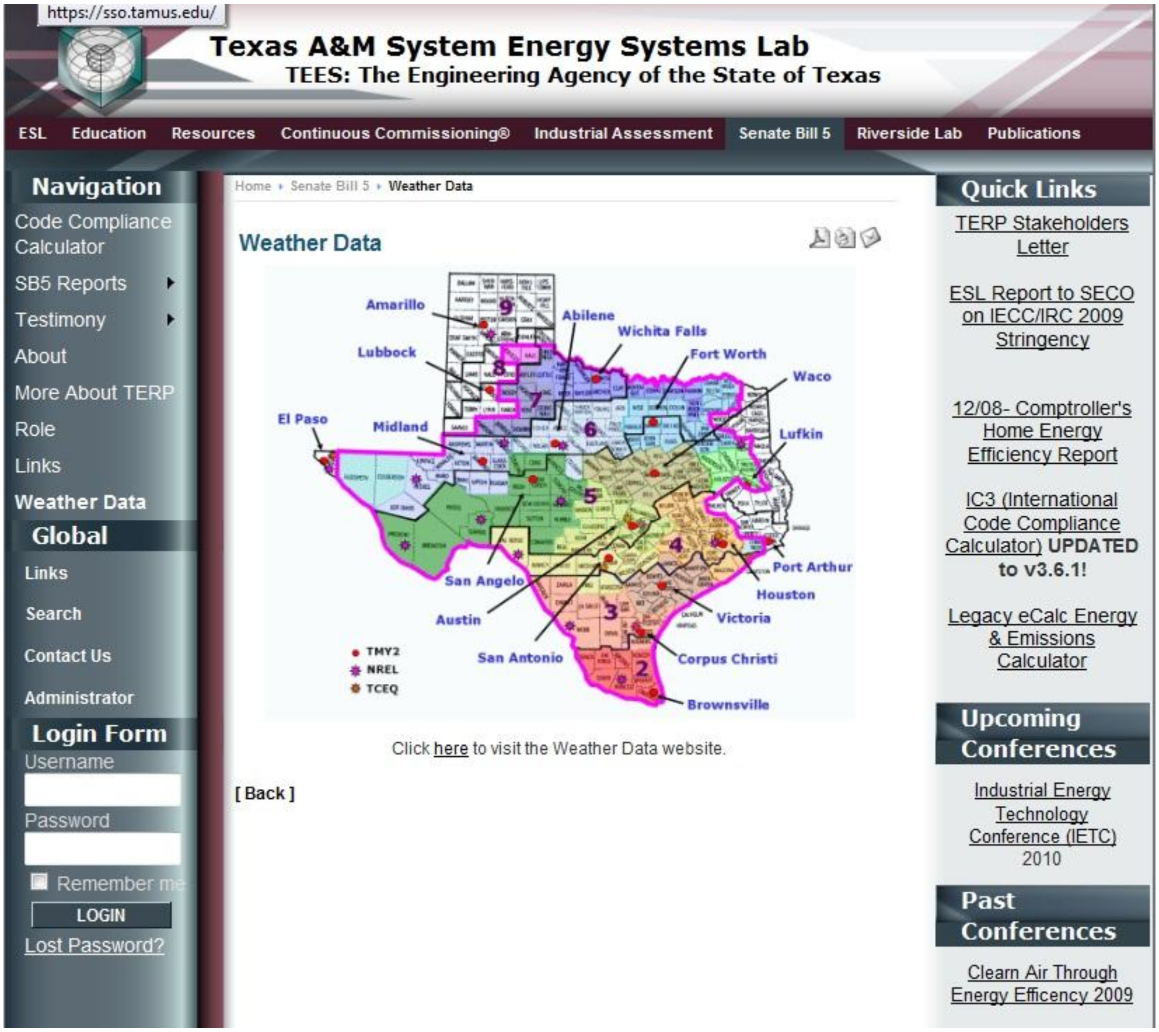


Figure 41: Web Page Providing Information about the Laboratory's TERP Weather Data Collection Effort

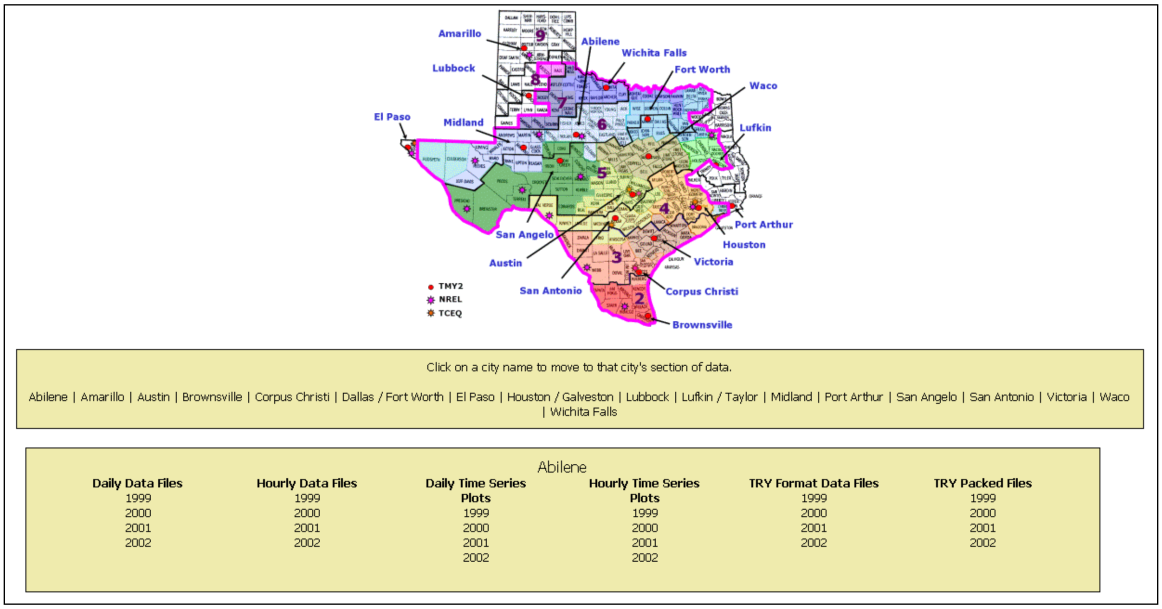


Figure 42: Web Page Providing Site-by-Site Weather Date from the Laboratory's TERP Effort

	A	B	C	D	E	F	G	H	I
1	Date	Average D	Average W	Average D	Average W	Total Glob	Total Norm	Total Precipitation (in)	
2	1/1/1999	55.8	49.8	44.4	14.8	505.4	62.1	0	
3	1/2/1999	35.3	29.3	18	14.1	986.1	1428.1	0	
4	1/3/1999	26.4	20.6	4.6	10.6	1022.2	1509.9	0	
5	1/4/1999	29.8	23.3	8.7	7.7	1179.2	2503.3	0	
6	1/5/1999	45.8	34.9	17.5	14.4	1185.2	2581.3	0	
7	1/6/1999	45.5	36.3	23.3	5	1179.5	2591.4	0	
8	1/7/1999	44.3	40.6	36.3	5.2	1181.4	2548.9	0	
9	1/8/1999	32.1	30.8	28.4	11.3	266.7	2.5	0	
10	1/9/1999	27.8	23.4	14.3	8.4	1203.3	2522.6	0	
11	1/10/1999	42.8	33.9	19.9	8.7	1197.9	2534	0	
12	1/11/1999	48.5	39.9	29.4	14.2	1191.9	2391	0	
13	1/12/1999	58.9	48.5	37.8	12.8	827.5	665.2	0	
14	1/13/1999	39.5	35.2	29.1	8	845	952.8	0	
15	1/14/1999	35.4	30.3	21.9	7.4	1225.2	2519.7	0	
16	1/15/1999	52.1	40	24.3	14.3	1263.5	2728.7	0	
17	1/16/1999	52.5	41.3	26.6	9.3	1232.4	2434.8	0	
18	1/17/1999	59.5	43.6	23	10.6	1225.5	2434.4	0	
19	1/18/1999	50.2	39	22.7	6.3	1222.9	2420.8	0	
20	1/19/1999	63.4	47.6	30.5	11.2	1239.1	2334.6	0	
21	1/20/1999	62.8	49.4	35.5	8.1	1123.7	1800.9	0	
22	1/21/1999	61.1	48.4	35	12.6	924.3	1174.1	0	
23	1/22/1999	42.3	38.2	32.3	13	153.1	3.8	0.1	
24	1/23/1999	45.8	38.9	30.3	7.2	1352	2865.3	0	
25	1/24/1999	60.3	45.3	27.8	9.2	1227.7	2216.6	0	
26	1/25/1999	48.1	41.2	32.9	6.2	1350.4	2326.6	0	
27	1/26/1999	60.3	51	42.5	16.9	1256.9	2140.8	0	
28	1/27/1999	59.9	53.9	49	10.5	817.7	650.3	0	
29	1/28/1999	54.1	50.9	48.3	10.8	587.5	162	0	
30	1/29/1999	37	36.9	36	10.2	116	0.6	1.8	
31	1/30/1999	40.2	37.6	34.4	11.8	595.1	236.2	0	

Figure 43: Spreadsheet Showing Daily Weather Date for Abilene, 1999

	A	B	C	D	E	F	G	H
1	Date time	Dry-Bulb T	Wet-Bulb T	Dew-Point	Wind Spee	Global Sol	Normal Dre	Precipitatio
2	1/1/1999 0:00	47	43	39	9	0	0	0
3	1/1/1999 1:00	47	45	43	16	0	0	0
4	1/1/1999 2:00	48	47	46	11	0	0	0
5	1/1/1999 3:00	49	48	48	14	0	0	0
6	1/1/1999 4:00	49	48	48	9	0	0	0
7	1/1/1999 5:00	49	48	48	11	0	0	0
8	1/1/1999 6:00	51	50	50	11	0	0	0
9	1/1/1999 7:00	54	53	52	15	0	0	0
10	1/1/1999 8:00	56	54	53	15	0.3	0	0
11	1/1/1999 9:00	60	56	53	15	13	1.3	0
12	1/1/1999 10:00	61	57	54	14	69.4	42.8	0
13	1/1/1999 11:00	62	57	54	19	53	0.6	0
14	1/1/1999 12:00	68	59	52	22	57.7	1.3	0
15	1/1/1999 13:00	68	58	50	19	95.4	7	0
16	1/1/1999 14:00	71	58	48	16	84.3	1.9	0
17	1/1/1999 15:00	71	56	44	7	73.2	0.6	0
18	1/1/1999 16:00	69	51	32	5	35.2	0.3	0
19	1/1/1999 17:00	64	49	33	6	20.6	6	0
20	1/1/1999 18:00	67	48	26	14	3.2	0.3	0
21	1/1/1999 19:00	56	50	44	25	0	0	0
22	1/1/1999 20:00	49	45	41	16	0	0	0
23	1/1/1999 21:00	45	43	41	23	0	0	0
24	1/1/1999 22:00	40	38	35	21	0	0	0
25	1/1/1999 23:00	38	35	31	23	0	0	0
26	1/2/1999 0:00	37	34	30	15	0	0	0
27	1/2/1999 1:00	35	32	27	22	0	0	0
28	1/2/1999 2:00	34	31	26	22	0	0	0
29	1/2/1999 3:00	33	30	24	26	0	0	0
30	1/2/1999 4:00	31	28	22	25	0	0	0
31	1/2/1999 5:00	30	27	21	22	0	0	0
32	1/2/1999 6:00	30	27	21	23	0	0	0
33	1/2/1999 7:00	29	26	21	16	0	0	0
34	1/2/1999 8:00	32	28	20	14	1.6	5.7	0
35	1/2/1999 9:00	33	28	18	16	38	176.9	0
36	1/2/1999 10:00	37	30	18	17	81.8	165.8	0
37	1/2/1999 11:00	39	31	17	19	140.5	282.8	0
38	1/2/1999 12:00	42	33	16	16	176.3	296.8	0
39	1/2/1999 13:00	43	33	17	16	179.8	257.1	0

Figure 44: Spreadsheet Showing Hourly Weather Date for Abilene, 1999

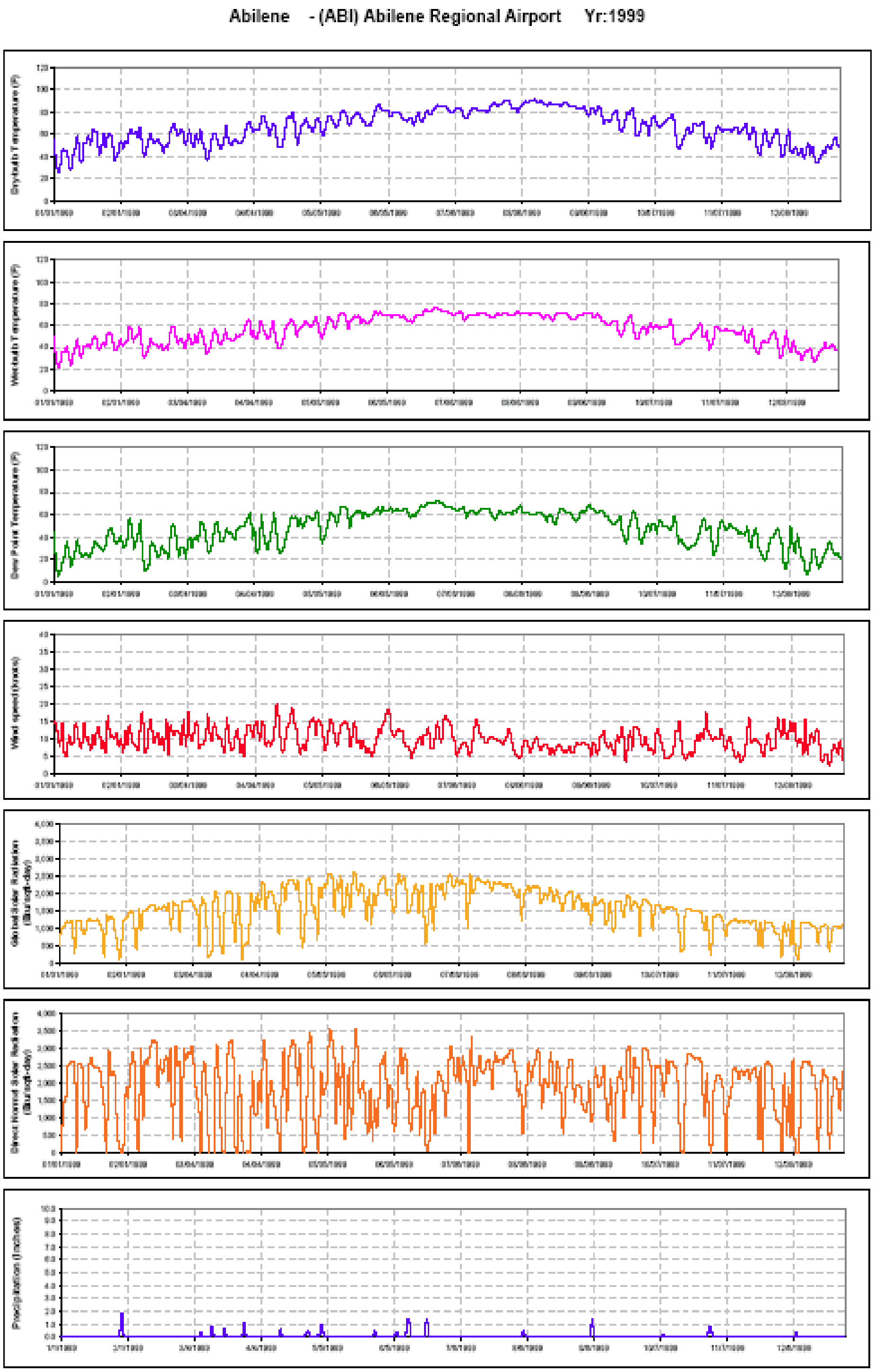


Figure 45: Time Series Graphs Showing Daily Weather Data for Abilene, 1999

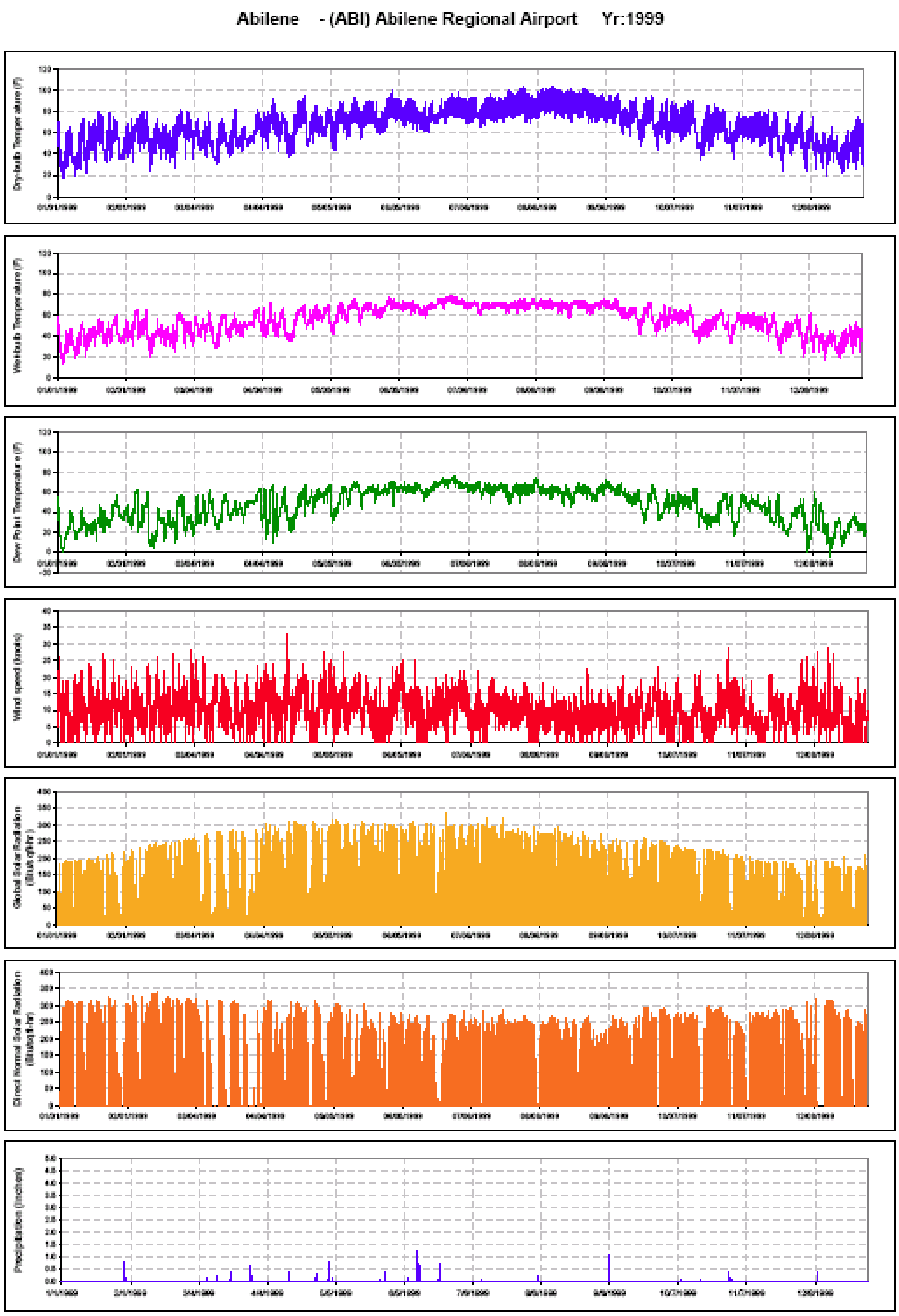


Figure 46: Time Series Graphs Showing Hourly Weather Data for Abilene, 1999

5.2.4 Provide Technical Assistance to the TCEQ

The Laboratory received dozens of calls per week from code officials, builders, home owners and municipal officials regarding the building code and emissions calculations. A complete file of these transactions is maintained at the Laboratory.

5.2.5 Delivered "Statewide Air Emissions Calculations from Wind and Other Renewables: Summary Report September 2008 – August 2009," to the Texas Commission on Environmental Quality in August 2009, revised November 2009 (Figure 47)

The Energy Systems Laboratory, in fulfillment of its responsibilities under this Legislation, submits its third annual report, "Statewide Air Emissions Calculations from Wind and Other Renewables," to the Texas Commission on Environmental Quality.

The report is organized in several deliverables:

- A Summary Report, which details the key areas of work;
- Supporting Documentation;
- Supporting data files, including weather data, and wind production data, which have been assembled as part of the third year's effort.

The executive summary provides summaries of the key areas of accomplishment this year, including:

- Continuation of stakeholder's meetings;
- Analysis of power generation from wind farms using improved method and 2006 data;
- Analysis of emissions reduction from wind farms;
- Updates on degradation analysis;
- Analysis of other renewables, including: PV, solar thermal, hydroelectric, geothermal and landfill gas;
- Review of electricity generation by renewable sources and transmission planning study reported by ERCOT;
- Review of combined heat and power projects in Texas; and
- Preliminary reporting of NOx emissions savings in the 2007 Integrated Savings report to the TCEQ.

5.2.5.1 Analysis of wind farms using improved method and 2007 data

In this report, the weather normalization procedures developed together with the Stakeholders were presented and applied to all the wind farms that reported their data to ERCOT during the 2007 measurement period, together with wind data from the nearby NOAA weather stations. In the 2008 Wind and Renewables report to the TCEQ (Haberl et al. 2008), weather normalization analysis methods were reviewed. An analysis was shown for the Sweetwater I wind farm in Nolan, Texas, and then applied to all the wind farms in the ERCOT region.

The wind farm (Sweetwater III) was used as an example in this report to present the same weather normalization procedure, including the processing of weather and power generation data, modeling of daily power generation versus daily wind speed using the ASHRAE Inverse Model Toolkit (IMT) for two separate periods, i.e., Ozone Season Days period (OSP), from July 15 to September 15, and Non-Ozone Season days period (Non-OSP); prediction of 1999 wind power generation using developed coefficients from 2007 daily OSP and Non-OSP models; and the analysis on monthly capacity factors generated using the models.

Then, a summary of total predicted wind power production in the base year (1999) for all of the wind farms in the ERCOT region using the developed procedure was presented and the new wind farms which started operation in 2007 were added. The total measured wind power generation in 2007 was 8,752,498 MWh, which is 17% less than what the same wind farms would have produced in 1999. The measured wind power generation in the OSP of 2007 was 20,094 MWh/day, which is 25% lower than the estimated 1999 OSD wind production.

This report also includes an uncertainty analysis that was performed on all the daily regression models for the entire year and Ozone Season Period.

5.2.5.2 Analysis of emissions reductions from wind farms

In this report, the procedure for calculating annual and peak-day, county-wide NOx reductions from electricity savings from wind projects implemented in the Power Control Areas in ERCOT listed in the EPA's eGRID was presented, including assigning the wind farms to PCA based on the information provided by the PUCT, and calculating the NOx emission reductions based on the special version of 2007 eGRID developed by the EPA for the TCEQ. According to the developed models, the total MWh savings in the base year 1999 for the wind farms within the ERCOT region were10,226,401 MWh and 25,152 MWh/day in the Ozone Season Period. The total NOx emissions reductions across all the counties amount to 6,051 tons/yr and 15 tons/day for the Ozone Season Period.

The ESL has been working with the EPA and TCEQ regarding a new version of eGRID for all ERCOT counties in Texas. A new version of eGRID was developed and presented in this report, which is based on the ERCOT congestion management zones. As the TCEQ moves the base year to more recent years, this updated version of eGRID, representing the current Texas market, may be used to estimate the emissions reduction from wind power in the next year's report.

5.2.5.3 Preliminary reporting of NOx emissions savings in the 2008 Integrated Savings report to TCEQ

In this report, the NOx emissions savings from the energy-efficiency programs from multiple Texas State Agencies working under Senate Bill 5 and Senate Bill 7 in a uniform format to allow the TCEQ to consider the combined savings for Texas' State Implementation Plan (SIP) planning purposes. This required that the analysis should include the cumulative savings estimates from all projects projected through 2020 for both the annual and Ozone Season Day (OSD) NOx reductions. The NOx emissions reduction from all these programs were calculated using estimated emissions factors for 2007 from the US Environmental Protection Agency (US EPA) eGRID database, which had been specially prepared for this purpose.

5.2.5.4 Development of a degradation analysis

This report contains an updated analysis to determine what amounts of degradation could be observed in the measured power from Texas wind farms. Currently, the TCEQ uses a very conservative 5% degradation per year for the power output from a wind farm when making future projections from existing wind farms. Accordingly, the TCEQ asked the ESL to evaluate any observed degradation from the measured data for Texas wind farms. To accomplish this, nine wind farms (12 sites) from 2002 to 2007 and two wind farms (Brazos wind ranch and Sweetwater) from 2004 to 2007 were evaluated with a total capacity of 1208 MW.

In this analysis, a sliding statistical index was established for each site that uses 10th, 25th, 50th, 75th, 90th, and 99th percentiles of the hourly power generation over a 12-month sliding period, as well as mean, minimum and maximum hourly power generation of the same 12-month period. These indices are then displayed using one data symbol for each 12-month slide, beginning from the first 12-month period until the last 12-month period for each of the wind farms.

Of the 14 sites analyzed, ten sites showed an increase when one compares the 90th percentile of whole period to the 90th percentile of the first 12-month period, ranging from 3.5% to 23.7%. The remaining four sites showed a decrease from -3.2% to -18.1%. The weighted average of this increase across all wind farms studied is 8.7% (positive), which indicates that no degradation was observed from the aggregate energy production from these wind farms over the studied operation period.

5.2.5.5 Analysis of other renewable sources

Other renewable energy projects throughout the state of Texas were located to determine NOx emissions reduction and are included in this section. Searches were conducted on five specific categories which include solar photovoltaic, solar thermal, geothermal, hydroelectric, and Landfill Gas-Fired Power Plants. Many newly located renewable energy projects are assembled for inclusion in this report.

5.2.5.6 Review of electricity savings and transmission planning study reported by ERCOT

In this report, the information posted on ERCOT's Renewable Energy Credit Program site www.texasrenewables.com is reviewed. In particular, information posted under the "Public Reports" tab was downloaded and assembled into an appropriate format for review. This includes ERCOT's 2001 through 2008 reports to the Legislature and information from ERCOT's listing of REC generators.

5.2.5.7 Review of Combined Heat and Power Projects in Texas

A summary of all the Combined Heat and Power (CHP) applications in Texas and analysis on how it can impact the NOx emissions was provided in this section. As of 2007, 16,829 MW of CHP technologies were integrated into infrastructure served by the Texas electrical grid according to the database maintained by the DOE and Oak Ridge National Laboratory.

ESL-TR-09-08-03

ENERGY EFFICIENCY/RENEWABLE ENERGY IMPACT IN THE TEXAS EMISSIONS REDUCTION PLAN (TERP)

PRELIMINARY REPORT: INTEGRATED NOX EMISSIONS SAVINGS FROM EE/RE PROGRAMS STATEWIDE

Annual Report to the
Texas Commission on Environmental Quality
January 2008 – December 2008

TCEQ

Jeff Haberl, Ph.D., P.E.; Charles Culp, Ph.D., P.E.
Bahman Yazdani, P.E.; Don Gilman, P.E.
Zi Liu, Ph.D., Juan-Carlos Baltazar-Cervantes, Ph.D.
Cynthia Montgomery, Kathy McKelvey,
Jaya Mukhopadhyay, Larry Degelman, P.E.

August 2009
Revised November 2009

ENERGY SYSTEMS LABORATORY

Texas Engineering Experiment Station
Texas A&M University System

Figure 47: Cover Page of "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)," Revised November 2009

5.2.6 Technical Assistance

The Laboratory provides technical assistance to the TCEQ, the PUC, SECO and ERCOT, as well as Stakeholders participating in a number of conferences and presentations. In 2009, the Laboratory continued to work closely with the TCEQ to develop an integrated emissions calculation, which provided the TCEQ with a creditable NOx emissions reduction from energy efficiency and renewable energy (EE/RE) programs reported to the TCEQ in 2005, 2006, 2007, and 2008 by the Laboratory, PUC, SECO, and Wind-ERCOT.

The Laboratory has also enhanced the previously developed emissions calculator by: expanding the capabilities to include all counties in ERCOT, including the collection and assembly of weather from 1999 to the present from 17 NOAA weather stations, and enhancing the underlying computer platform for the calculator.

The Laboratory has and will continue to provide leading edge technical assistance to counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering the emissions and improving the air for all Texans. The Laboratory will continue to provide superior technology to the State of Texas through efforts with the TCEQ and US EPA. The efforts taken by the Laboratory have produced significant success in bringing EE/RE closer to US EPA acceptance in the SIP.

ENERGY SYSTEMS LABORATORY
Texas Engineering Experiment Station
Texas A&M University System

3581 TAMU
College Station, Texas 77843-3581

September 29th, 2009

Mr. Felix Lopez, P.E.
Senior Engineer
State Energy Conservation Office
Comptroller of Public Accounts
111 East 17th Street, Room 114
Austin, Texas 78701

Dear Felix:

In accordance with the Health and Safety Code Section 388.003, as amended, the Laboratory reviewed and considered the comments received and performed a technical analysis that compared the stringency of the Texas Building Energy Performance Standards, based on the 2000 International Energy Conservation Code with the 2001 Supplement (2000/2001 IECC), to the 2009 IECC and Chapter 11 of the 2009 IRC.

The Laboratory recommends that Texas, through the State Energy Conservation Office's (SECO) rulemaking process, adopt the 2009 IECC and the Chapter 11 of the 2009 IRC, as statewide energy codes. The state should immediately begin educating, training, and providing technical assistance for building professionals and enforcement officials to enable statewide compliance.

The Laboratory's analysis has determined that:

1. For residential construction with 15% or less window to floor ratio, the residential prescriptive provisions of the 2009 IECC and the Chapter 11 of the 2009 IRC are as stringent as the Texas Building Energy Performance Standards (TBEPS), which is based on the 2000/2001 IECC (see attached tables for details). The Laboratory's analysis of the 2009 IECC and the Chapter 11 of the 2009 IRC indicate a marginal improvement in overall residential energy efficiency of the 2009 IECC over the energy provisions of the 2009 IRC.

2. For all other residential structures, the residential performance provisions of the 2009 IECC are as stringent as the TBEPS based on the 2000/2001 IECC.

3. The commercial provisions of the 2009 IECC are as stringent as the TBEPS based on the 2000/2001 IECC.

The Laboratory recognizes that several major municipalities are in the process of adopting energy codes that are equal to the 2009 IECC and/or the energy provisions of the 2009 IRC Codes. Although builders, suppliers, and manufacturers will be required to meet the newly adopted codes, and will need to retrain their employees and restock their supplies to meet the new requirements of the more stringent code, implementation of improved codes should be effected as soon as possible in order to maximize desired emissions reductions. An increased number of raters, inspectors and code officials will also be required to handle the increased demand. The Laboratory recognizes the challenge of these efforts and is ready to

Figure 48: Letter to SECO, pg. 1

assist SECO. The Laboratory is also in the process of updating the International Code Compliance Calculator (IC3) to facilitate compliance with the new residential provisions of the 2009 IECC.

Notwithstanding the comparisons in overall energy efficiency, the Laboratory observes the potentially greater reduction in peak demand associated with the 0.30 SHGC limitations found in the 2009 IECC. This, in addition to the corresponding emissions reduction resulting from the peak demand savings, provides enhanced benefits over a higher SHGC in compliance with the goals of the Texas Building Energy Performance Standards in the Health & Safety Code Section 388. 001.

The Laboratory recommends compliance with the 2009 IECC or the Chapter 11 of the 2009 IRC when using the prescriptive path for residential evaluation of residences with 15% or less window to floor ratio, since both are more stringent than the current TBEPS. The Laboratory also recommends using the 2009 IECC when using the performance path for all other residential evaluations.

These new codes will further Texas' Emission Reduction Plan (TERP) goals in improving air quality. Furthermore, adoption of the 2009 IECC is a requirement for securing American Recovery and Reinvestment Act (ARRA) Federal funding for Texas.

Sincerely,

Bahman Yazdani, P.E. Associate Director	Charles Culp, P.E., Ph.D. Associate Director	Jeff Haberl, P.E., Ph.D. Associate Director

cc: David Claridge, P.E., Ph.D., Director – ESL

Figure 49: Letter to SECO, pg. 2

Table 1: 2000/2001 IECC Performance Path vs. 2009 IECC Performance Path

County	IECC 2009 Weather Zones	Energy Type**	Total Annual Savings of the IECC 2009 Performance Path compared to the IECC 2000/2001 (%)*	
			Gas Heating, DHW	Heat Pump Heating, Electric DHW
Houston (HAR)	2A	Site	10.9 %	10.9 %
		Source	11.9 %	10.9 %
Brownsville (CAM)	2B	Site	16.4 %	13.6 %
		Source	15.1 %	13.6 %
Dallas (TAR)	3A	Site	12.8 %	10.8 %
		Source	12.3 %	10.8 %
El Paso (ELP)	3B	Site	10.2 %	10.0 %
		Source	11.2 %	10.0 %
Amarillo (ARM)	4B	Site	16.0 %	14.6 %
		Source	16.7 %	14.6 %

**Base-case Simulation Assumptions:* Analysis used single-family house, 2,500 ft^2, single story, four bedrooms, slab-on-grade, ducts in the unconditioned, ventilated attic, window-to-floor ratio: 18% for 2000/2001, 15% for 2009, windows equally distributed (N,E,S,W), and no exterior shading. HVAC Distribution efficiency: 0.8 for 2000/2001, 0.88 for 2009. All other roof, wall and window parameters as per 2000/2001 and 2009 IECC for county shown (IC3 ver. 3.03.02).

***Source Energy Consumption*: A factor of 3.16 was used to calculate the source electricity consumption. A factor of 1.1 was used to calculate source gas energy consumption.

Table 2: 2000/2001 IECC Performance Path vs. 2009 IECC Prescriptive Path

County	IECC 2009 Weather Zones	Energy Type**	Total Annual Savings of the IECC 2009 Prescriptive Path compared to the IECC 2000/2001 (%)*	
			Gas Heating, DHW	Heat Pump Heating, Electric DHW
Houston (HAR)	2A	Site	7.8 %	8.7 %
		Source	9.1 %	8.7 %
Brownsville (CAM)	2B	Site	14.3 %	11.6 %
		Source	13.0 %	11.6 %
Dallas (TAR)	3A	Site	9.6 %	8.6 %
		Source	9.6 %	8.6 %
El Paso (ELP)	3B	Site	7.0 %	8.3 %
		Source	8.9 %	8.3 %
Amarillo (ARM)	4B	Site	10.7 %	11.9 %
		Source	13.1 %	11.9 %

**Base-case Simulation Assumptions:* Analysis used single-family house, 2,500 ft^2, single story, four bedrooms, slab-on-grade, ducts in the unconditioned, ventilated attic, window-to-floor ratio: 18% for 2000/2001, 15% for 2009, windows equally distributed (N,E,S,W), and no exterior shading. HVAC Distribution efficiency: 0.8 for 2000/2001; for 2009 IECC, HVAC distribution efficiency simulated using R8 insulation for supply, R6 for return ducts and total duct leakage of 11% to outdoor. All other roof, wall and window parameters as per 2000/2001 and 2009 IECC for county shown (IC3 ver. 3.03.02).

***Source Energy Consumption*: A factor of 3.16 was used to calculate the source electricity consumption. A factor of 1.1 was used to calculate source gas energy consumption.

Figure 50: Letter to SECO, pg. 3

Table 3: 2000/2001 IECC Performance Path vs. Chapter 11 of the 2009 IRC Prescriptive Path

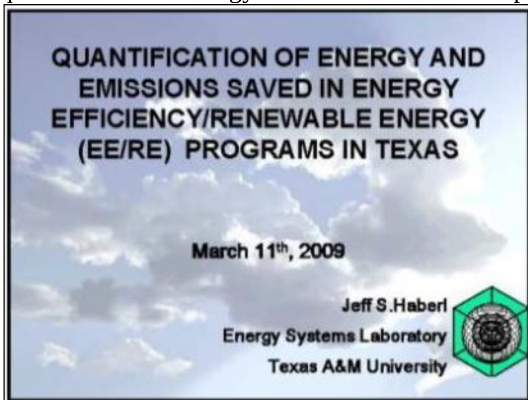
County	IECC 2009 Weather Zones	Energy Type**	Total Annual Savings of the IRC 2009 compared to the IECC 2000/2001 (%)*	
			Gas Heating, DHW	Heat Pump Heating, Electric DHW
Houston (HAR)	2A	Site	7.7 %	7.7 %
		Source	8.3 %	7.7 %
Brownsville (CAM)	2B	Site	13.7 %	10.4 %
		Source	11.8 %	10.4 %
Dallas (TAR)	3A	Site	9.9 %	7.8 %
		Source	9.0 %	7.8 %
El Paso (ELP)	3B	Site	7.1 %	7.1 %
		Source	7.9 %	7.1 %
Amarillo (ARM)	4B	Site	10.7 %	11.9 %
		Source	13.1 %	11.9 %

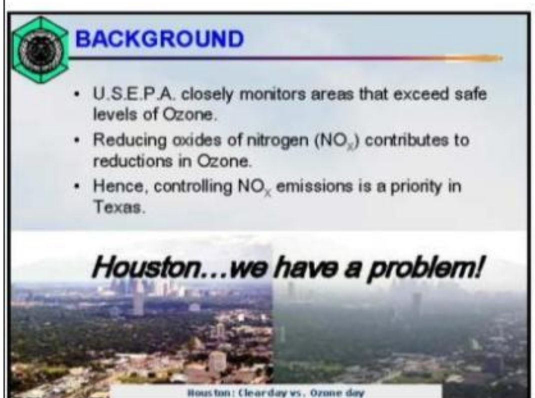
**Base-case Simulation Assumptions:* Analysis used single-family house, 2,500 ft^2, single story, four bedrooms, slab-on-grade, ducts in the unconditioned, ventilated attic, window-to-floor ratio: 18% for 2000/2001, 15% for 2009 IRC, windows equally distributed (N,E,S,W), and no exterior shading. HVAC Distribution efficiency: 0.8 for 2000/2001; for 2009 IRC, HVAC distribution efficiency simulated using R8 insulation for supply, R6 for return ducts and total duct leakage of 11% to outdoor. All other roof, wall and window parameters as per 2000/2001 and 2009 IRC for county shown (IC3 ver. 3.03.02).
***Source Energy Consumption*: A factor of 3.16 was used to calculate the source electricity consumption. A factor of 1.1 was used to calculate source gas energy consumption.

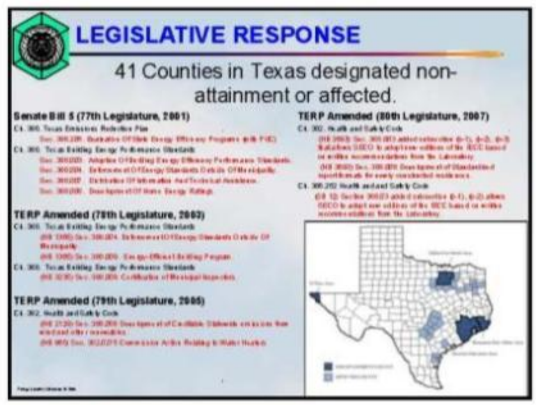
Figure 51: Letter to SECO, pg. 4

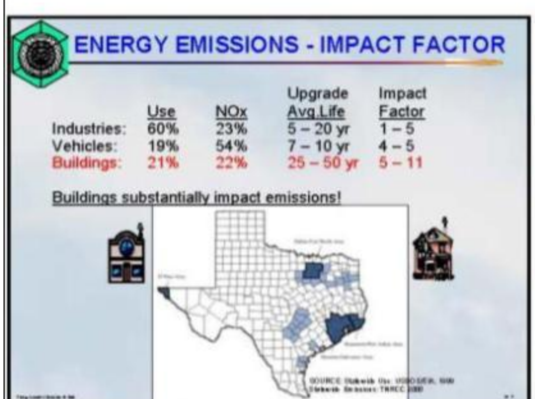
5.2.6.1 Presentation to EPA Sustainable Skylines, Dallas (March 2009)

In March of 2009, the Energy Systems Lab made a presentation to the EPA Sustainable Skylines about the quantification of energy and emissions saved in programs in Texas in Dallas, Texas.









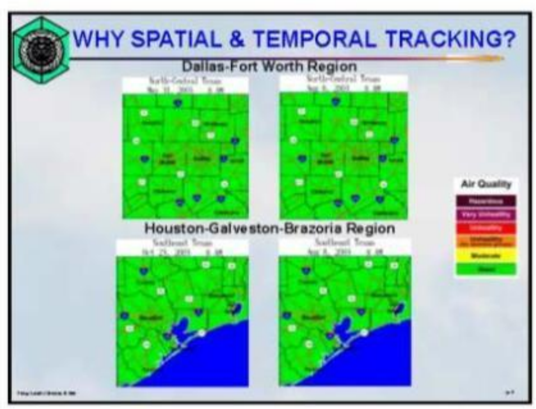
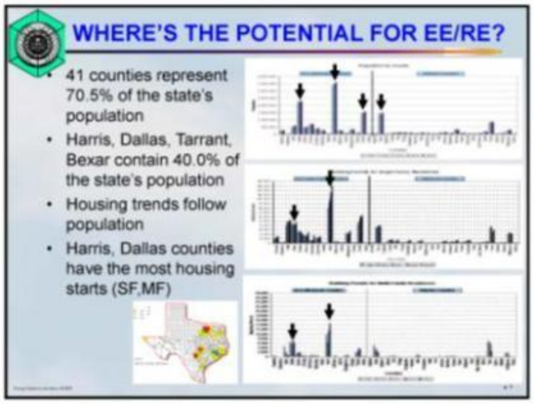
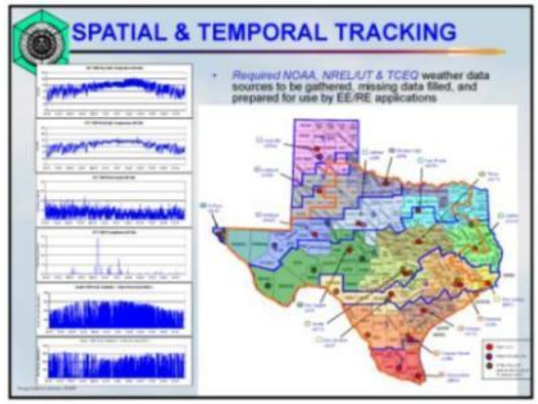
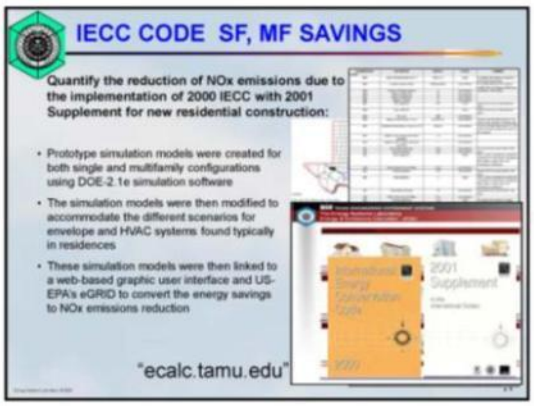
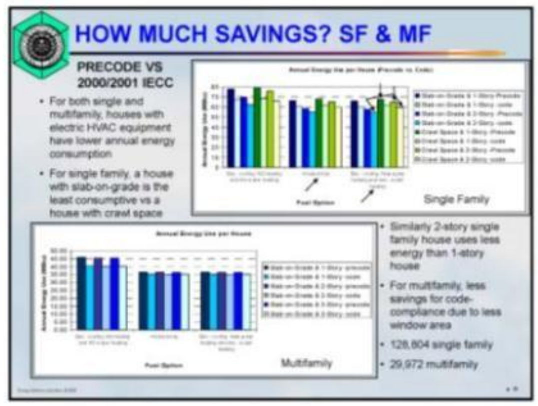


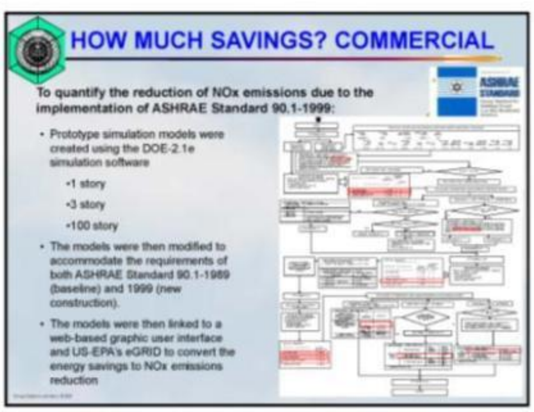
Figure 52 : Presentation to EPA Sustainable Skylines, Dallas (March 2009) (Part 1)











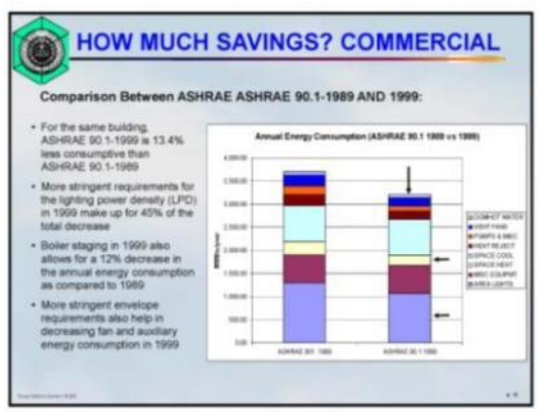
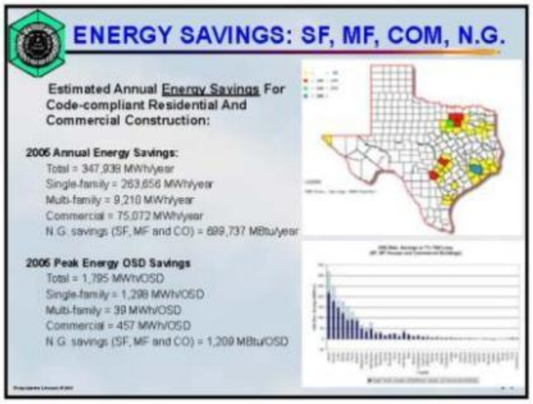
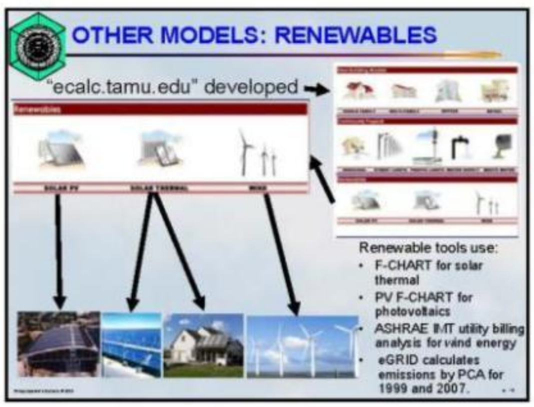
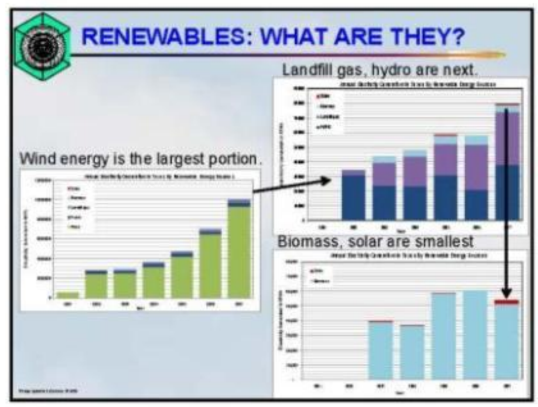
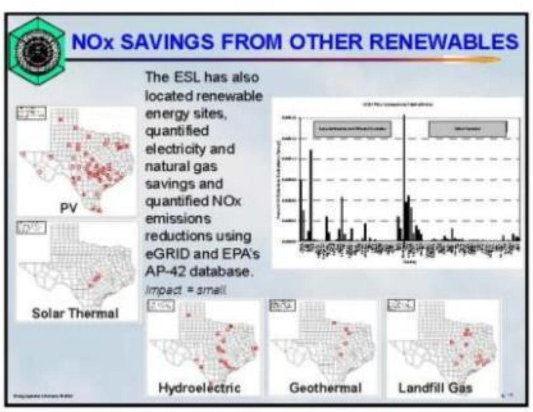


Figure 53: Presentation to EPA Sustainable Skylines, Dallas (March 2009) (Part 2)









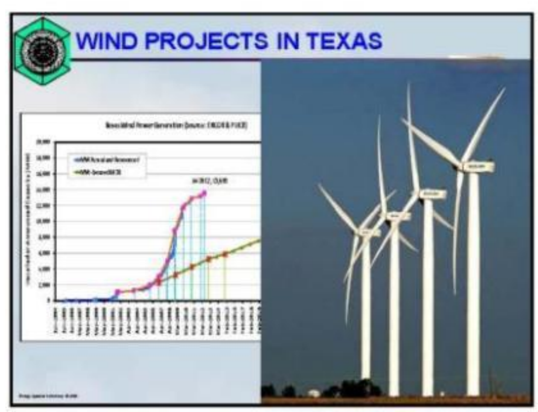
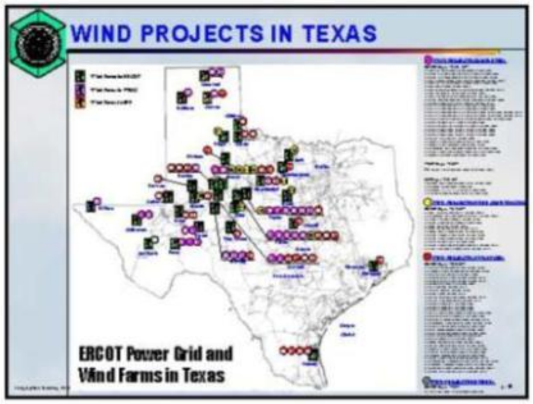
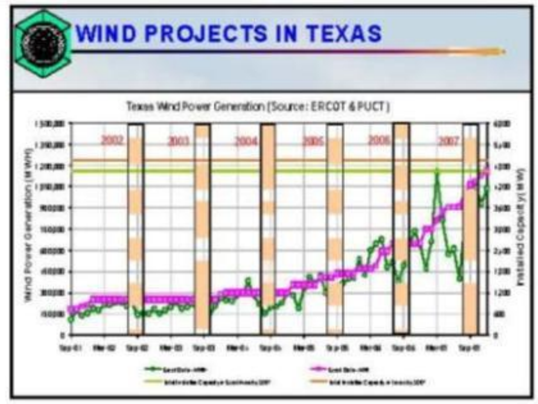
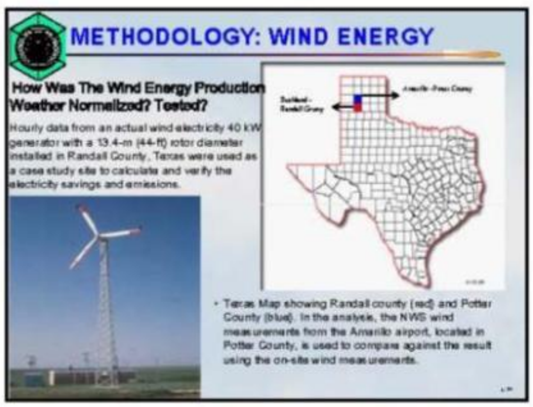
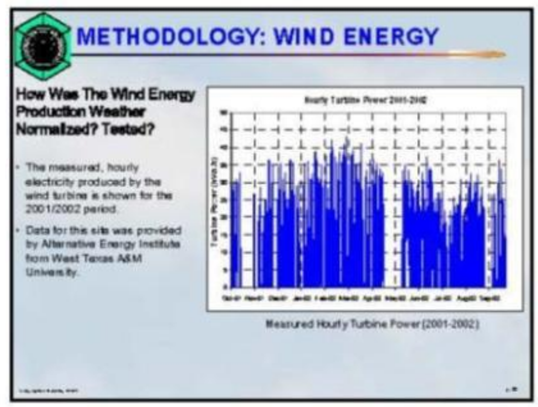


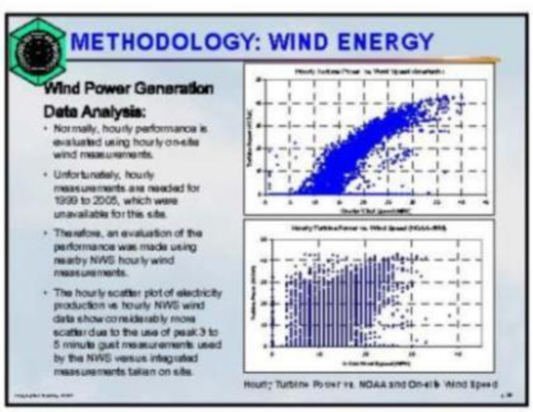
Figure 54: Presentation to EPA Sustainable Skylines, Dallas (March 2009) (Part 3)











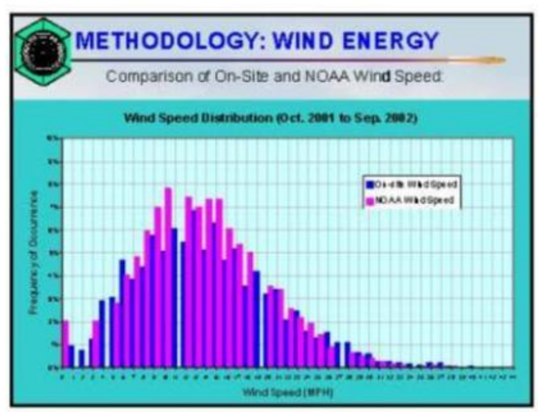


Figure 55: Presentation to EPA Sustainable Skylines, Dallas (March 2009) (Part 4)

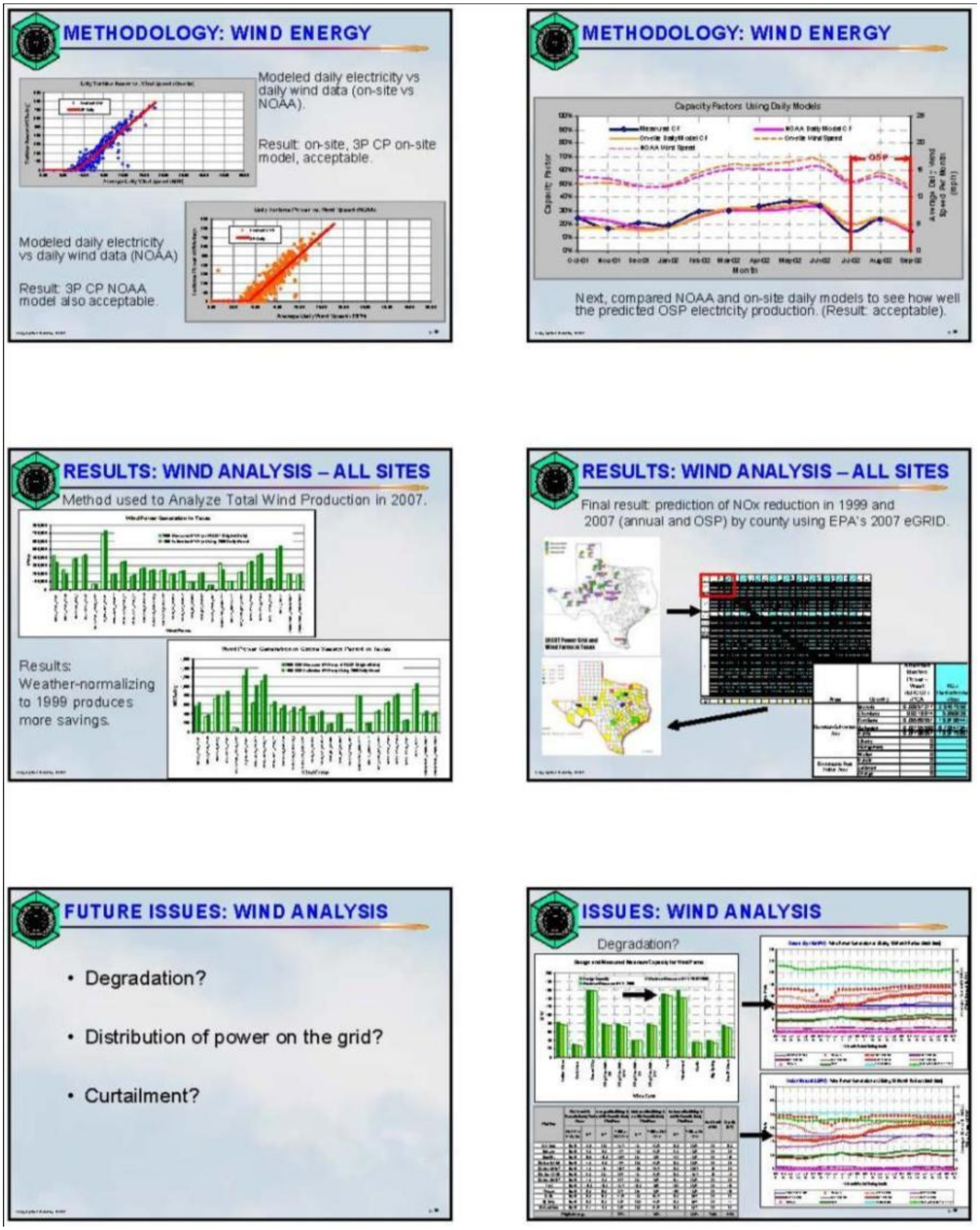
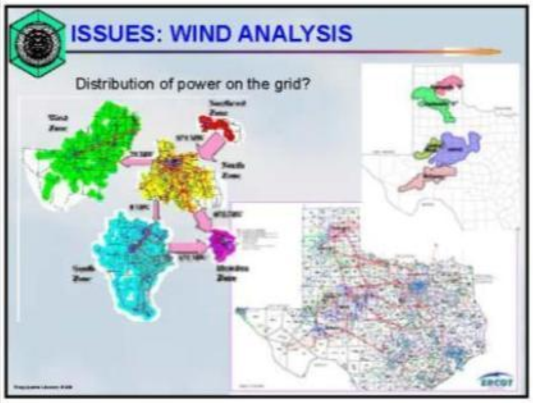
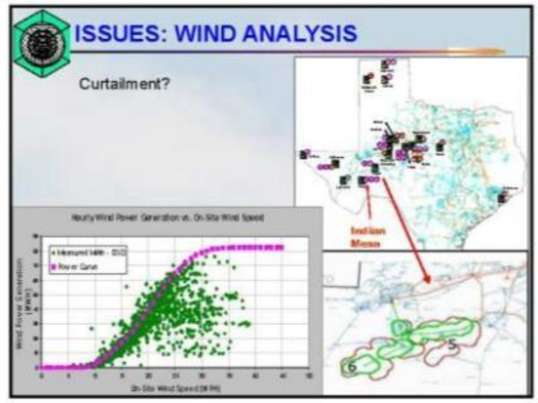
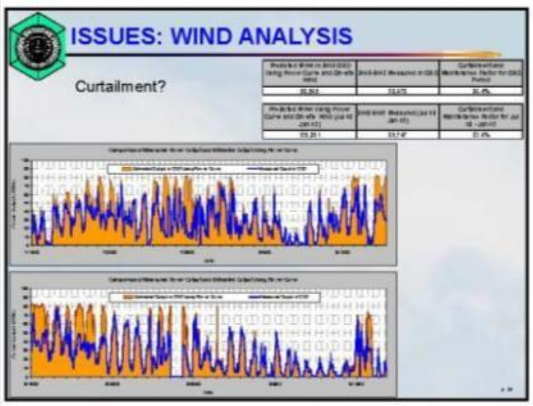
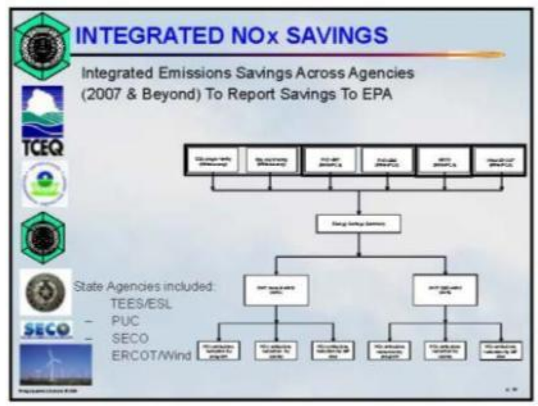


Figure 56: Presentation to EPA Sustainable Skylines, Dallas (March 2009) (Part 5)









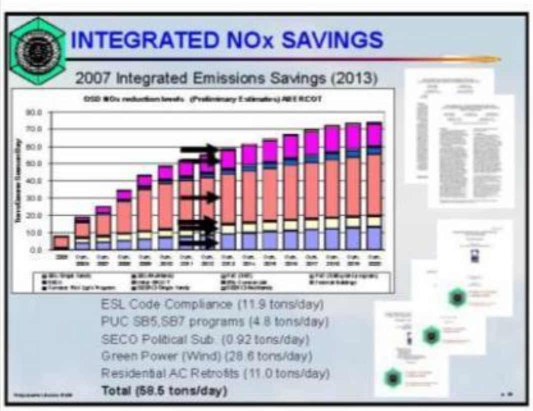


Figure 57: Presentation to EPA Sustainable Skylines, Dallas (March 2009) (Part 6)

5.2.6.2 Presentation to the Texas Senate and Energy Efficiency Committee, Austin (March 2009)

In March of 2009, the Energy Systems Lab made a presentation to the Texas Senate and Energy Efficiency Committee about CO_2 Emissions Reduction Potential in Austin, Texas.

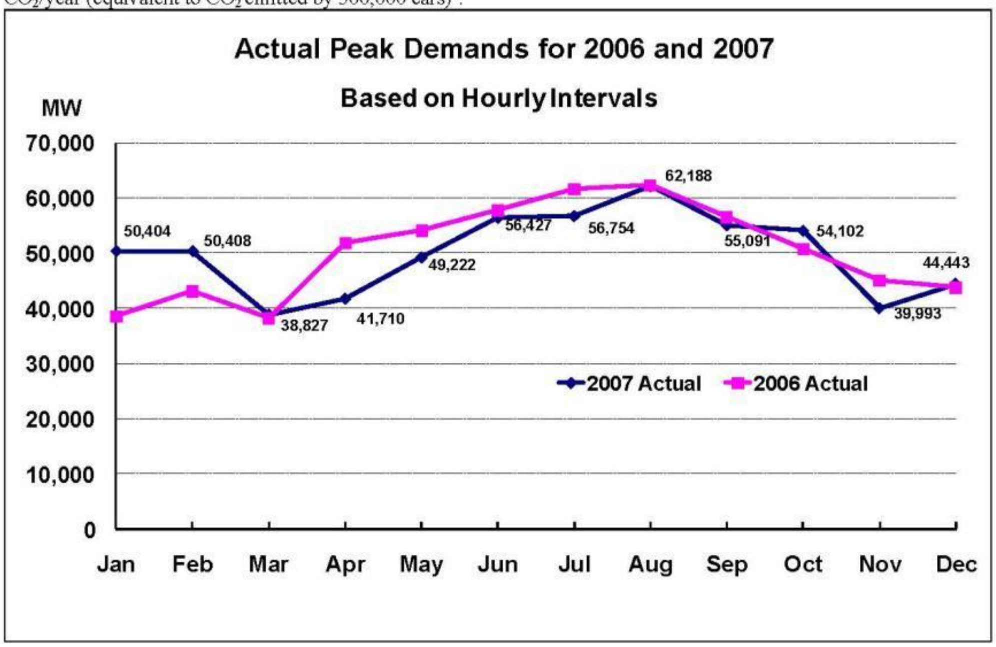
C02 Emissions Reduction Potential From a 1% to 5% ERCOT-wide Peak Electric Demand Reduction

The potential electricity and CO_2 emissions reductions from a 1% to 5% peak electric demand reduction across the ERCOT region during peak periods can be estimated as follows. In the figure below the actual ERCOT peak monthly demands[1] are shown for 2006 and 2007. From these data if one assumes the peak demand using August of 2007 (i.e., 62,188 MW), a 1% to 5% demand reduction could be 622 MW to 3,110 MW.

Using the MWh to CO_2 conversion values from the 2007 edition of the USEPA's eGRID database[2], and proportioning the electricity sales data in the ERCOT region according to the published electricity sales data for Texas in 1998[3], the CO_2 emissions reduction from one hour of electricity savings of 622 MWh to 3,110 MWh could be as much as 388.3 to 1,941.6 tons-CO_2.

If the peak demand reduction were to continue for a four hour period, for example from 12:00 Noon to 4:00 PM, the electricity reduction could be 2,488 to 12,440 MWh, with a corresponding CO_2 emissions reduction of 1,553 to 7,766 tons-CO_2/day. By comparison, in 2005 it was estimated[4] that the average daily electricity savings from the code-compliant new construction for single family residential during an ozone season day (OSD) was 776 MWh, with a corresponding CO_2 emissions reduction of 485 tons-CO_2/day.

If these peak electric demand reductions could be continued throughout the year the electricity reduction could be 908,120 to 4,540,600 MWh/year with a corresponding CO_2 emissions reduction of 566,941 to 2,834,708 tons-CO_2/year (equivalent to CO_2 emitted by 500,000 cars)[5].



[1] Data obtained from ERCOT - File Name: ERCOT2007D&E011108.xls (Updated 01/16/2008).

[2] This is a special version of eGRID developed by the EPA for the TCEQ that reflects the 2007 electricity and pollution from electric utilities in ERCOT during the 1998 to 1999 period based on selected growth assumptions for 2007.

[3] Electricity was proportioned according to the TPUC total sales for 1998 by Power Control Authority as follows: AEP (11.2%), Austin Energy (1.3%), Brownsville Public Power (0.1%), LCRA (4.1%), Reliant (35.2%), San Antonio Public Power (4.9%), Texas Municipal Power (3.0%), Texas-New Mexico Power (3.5%), TXU (35.7%).

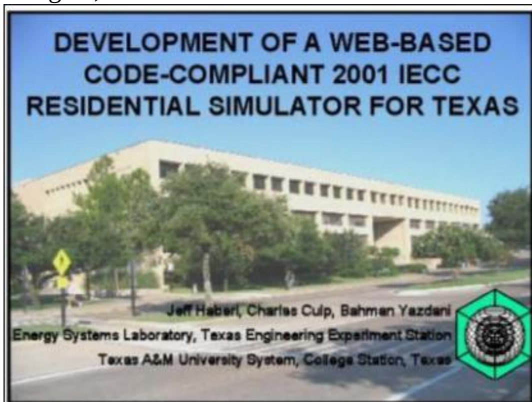
[4] Haberl, J., Culp, C., Yazdani, B., Gilman, D., Liu, Z., Baltazar, J., Montgomery, C., McKelvey, K, Mukhopadyay, J., Degelman, L. 2008. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP): Preliminary Report to the TCEQ", Energy Systems Laboratory ESL-TR-08-08-01, Texas A&M University System, p. 15 (August).

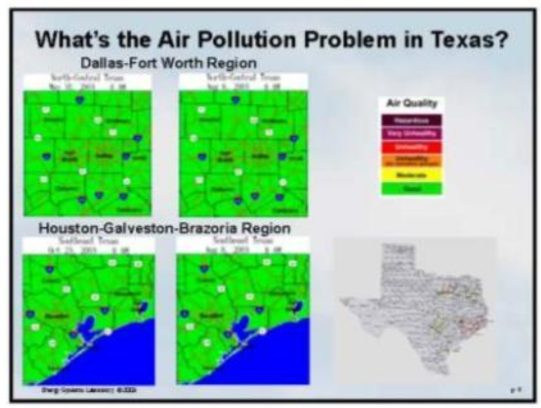
[5] These estimates assume that the electricity reductions during the peak demand periods are actual electricity reductions and not peak shifting. In addition, this estimate assumes that no other form of non-renewable energy is consumed to off-set the peak electricity reductions.

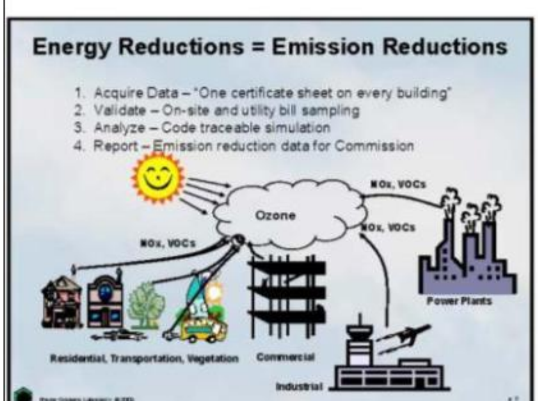
Figure 58: Presentation to the Texas Senate and Energy Efficiency Committee, Austin (March 2009)

5.2.6.3 Presentation to IBPSA, Glasgow, Scotland (July 2009)

In July of 2009, Dr. Jeff Haberl made a presentation at the International Building Simulation Association about the development of a web-based code-compliant 2001 IECC residential simulator for Texas in Glasgow, Scotland.







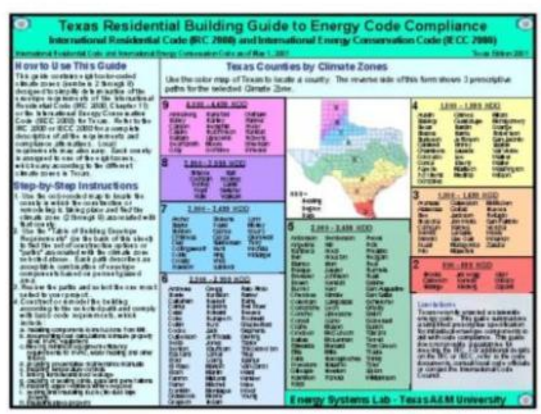
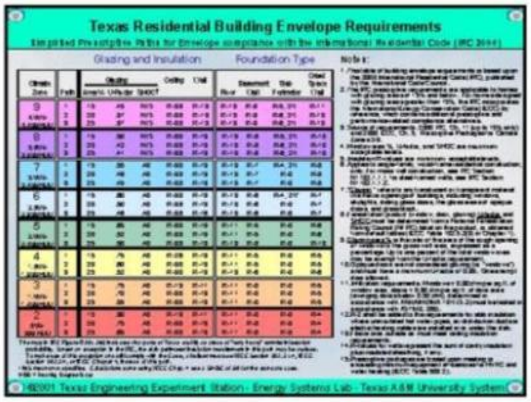
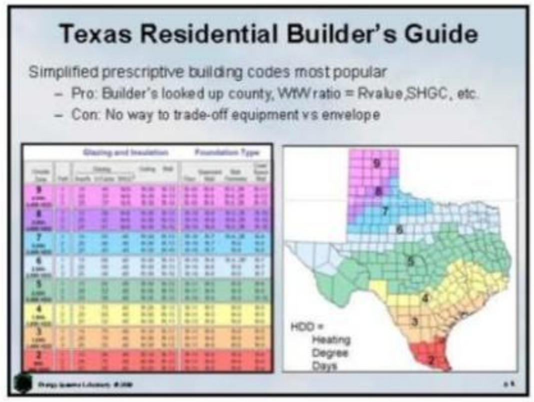
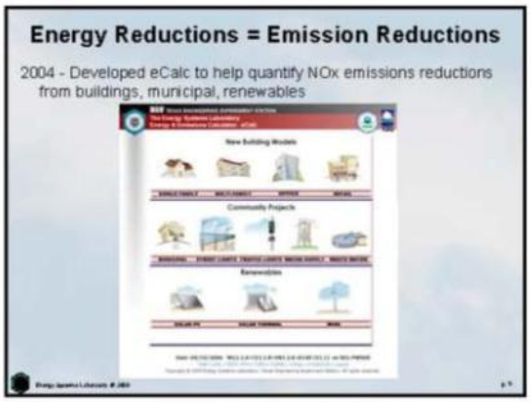
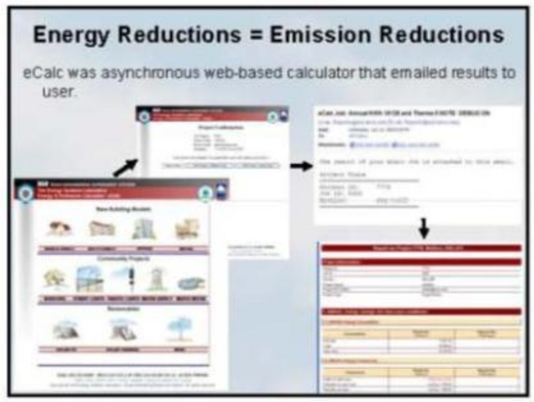


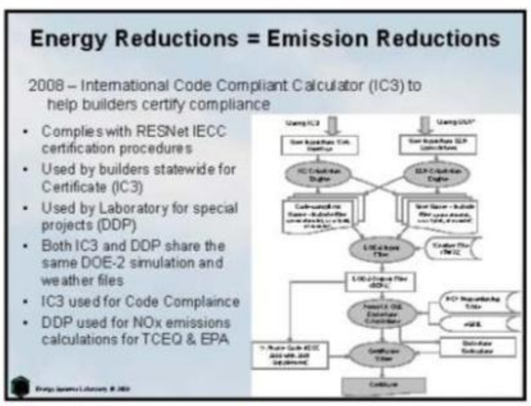
Figure 59: Presentation to IBPSA, Glasgow, Scotland (July 2009) (Part 1)











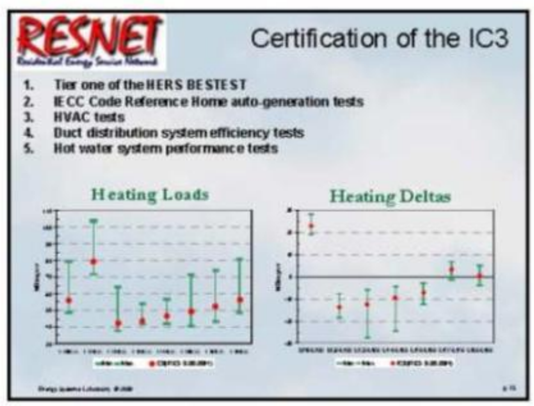
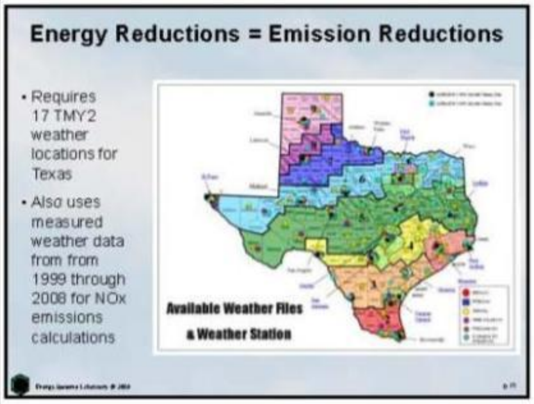
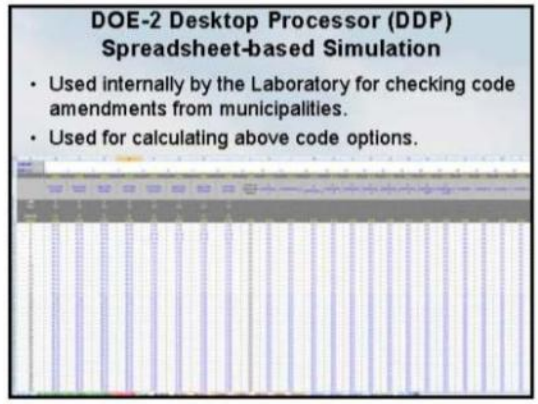
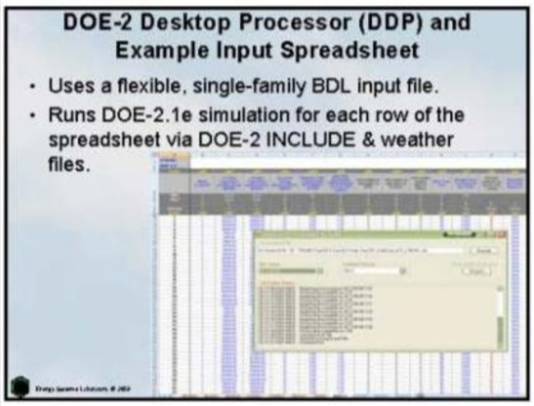
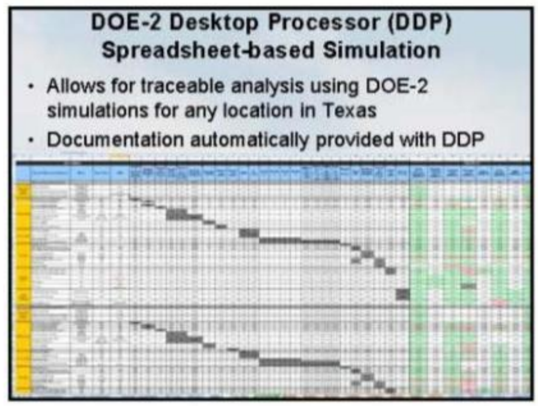


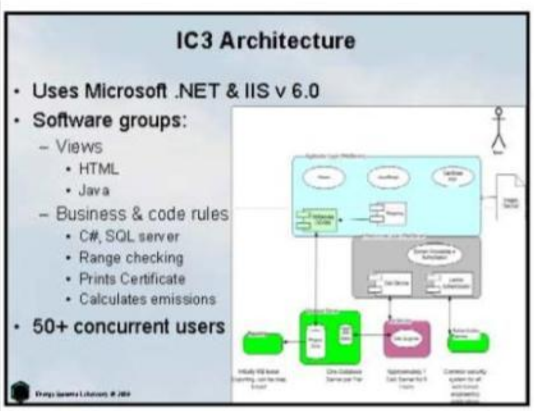
Figure 60: Presentation to IBPSA, Glasgow, Scotland (July 2009) (Part 2)











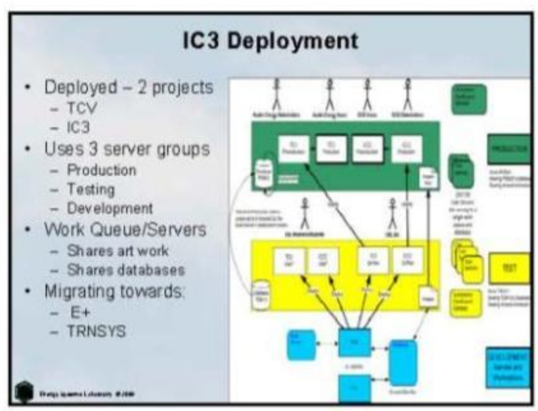
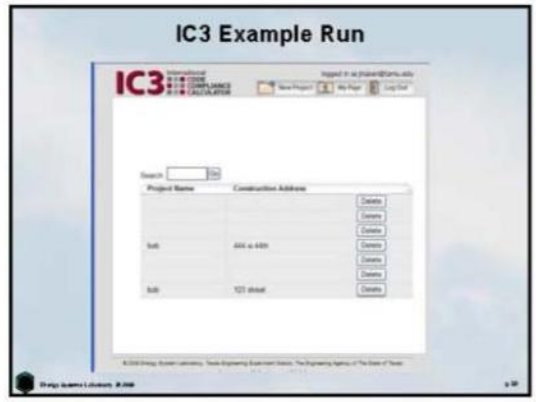
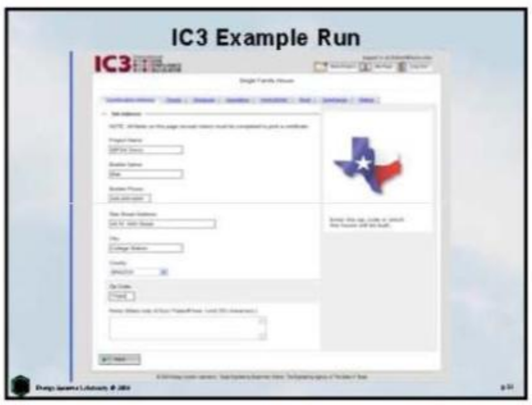


Figure 61: Presentation to IBPSA, Glasgow, Scotland (July 2009) (Part 3)





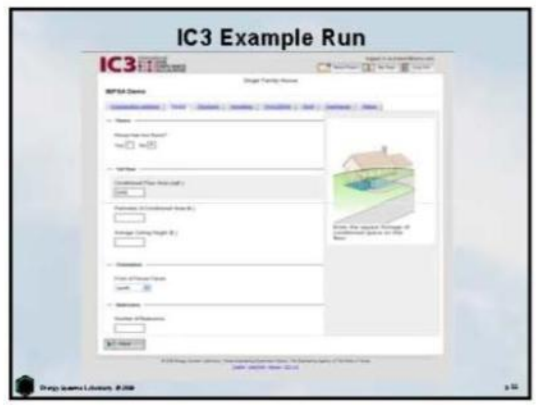


Figure 62: Presentation to IBPSA, Glasgow, Scotland (July 2009) (Part 4)

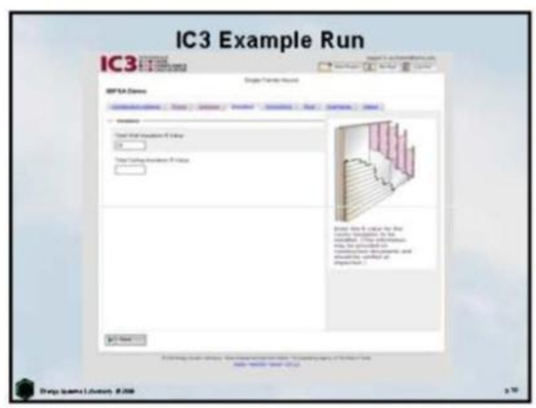


Figure 63: Presentation to IBPSA, Glasgow, Scotland (July 2009) (Part 5)

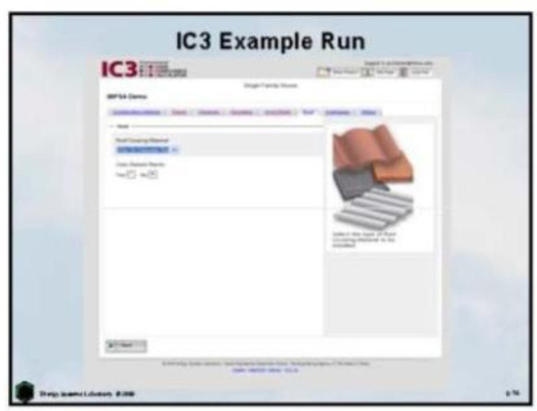
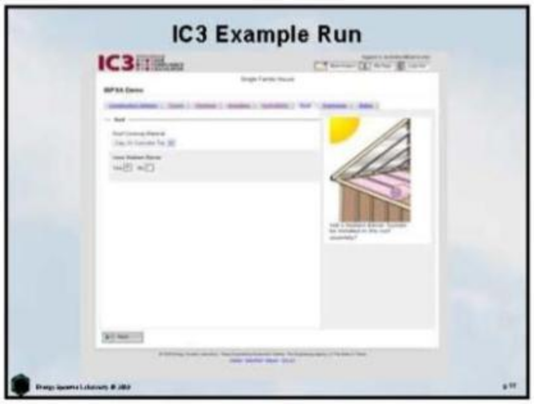
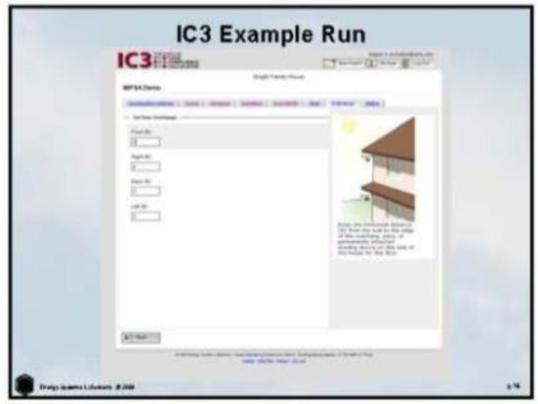
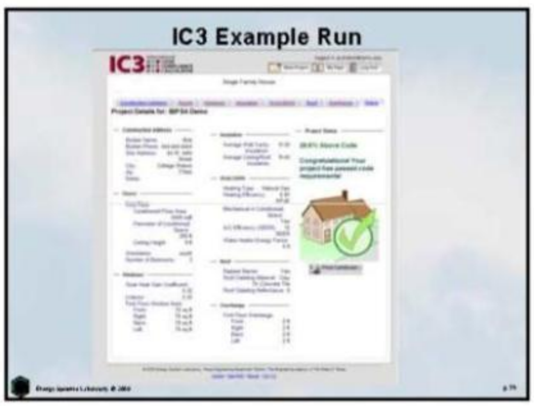
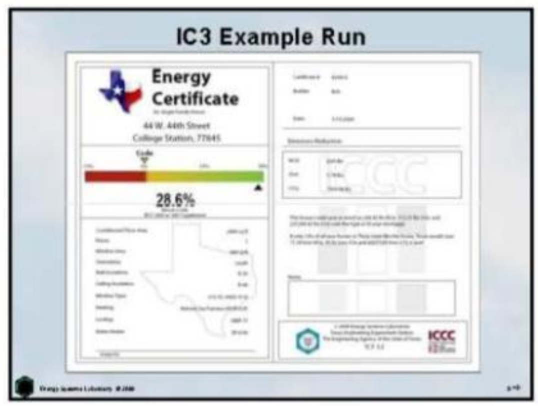


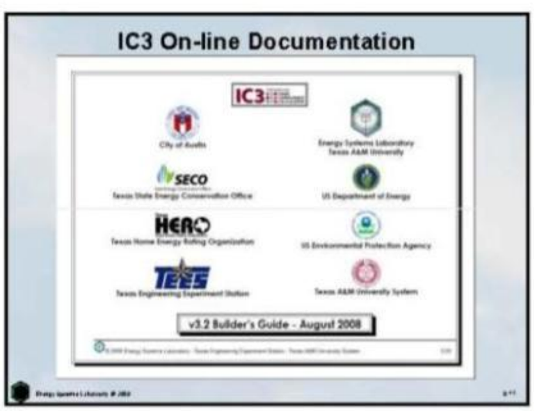
Figure 64: Presentation to IBPSA, Glasgow, Scotland (July 2009) (Part 6)











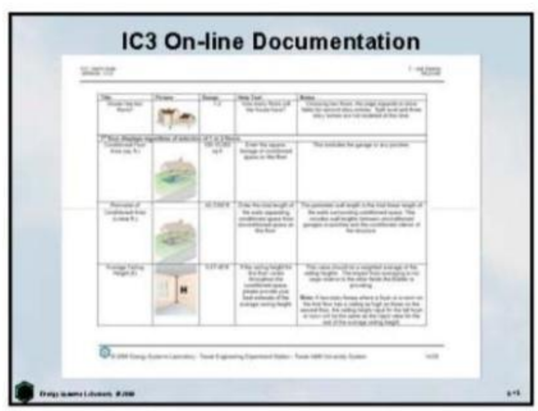


Figure 65: Presentation to IBPSA, Glasgow, Scotland (July 2009) (Part 7)

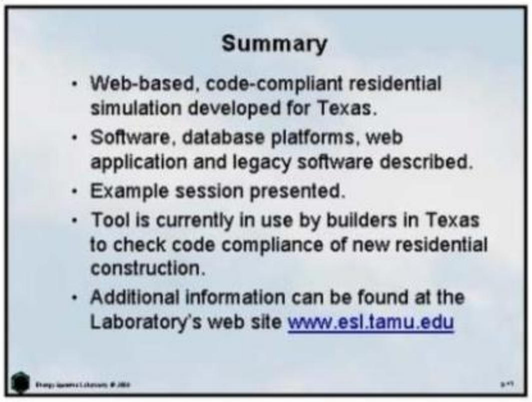
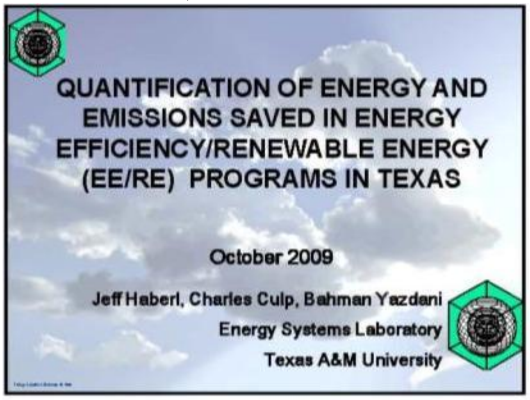
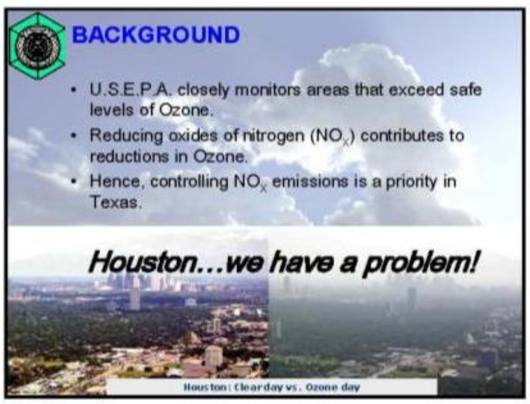


Figure 66: Presentation to IBPSA, Glasgow, Scotland (July 2009) (Part 8)

5.2.6.4 Presentation at CATEE Conference, Houston (October 2009)

In October of 2009, the Energy Systems Lab made a presentation at the CATEE conference about the quantification of energy and emissions saved in Energy Efficiency/Renewable Energy (EE/RE) programs in Texas Houston, Texas.





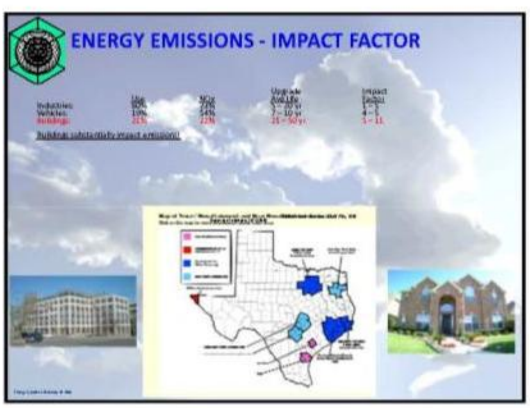
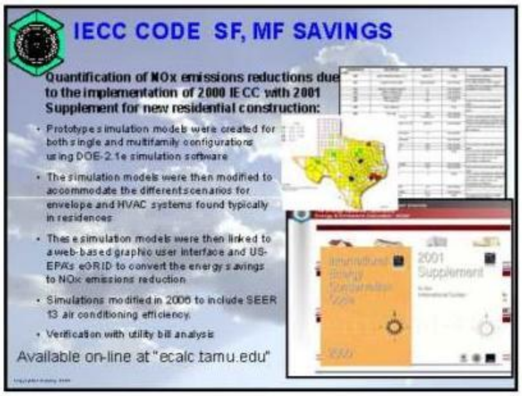
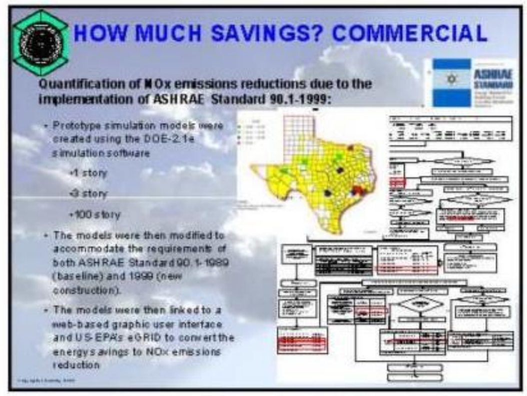
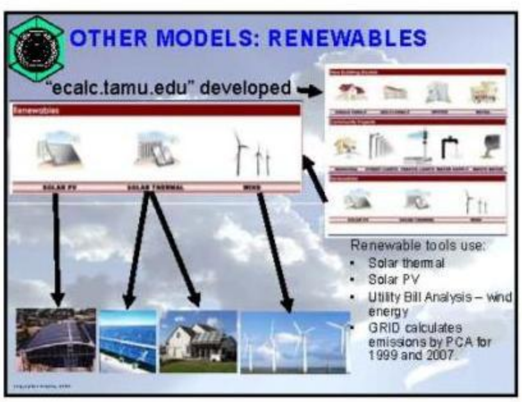


Figure 67: Presentation at CATEE Conference, Houston (October 2009) (Part 1)







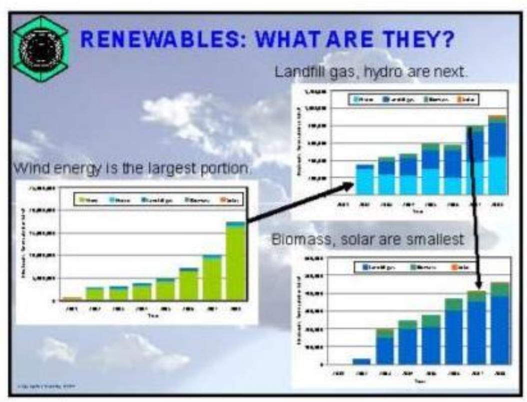
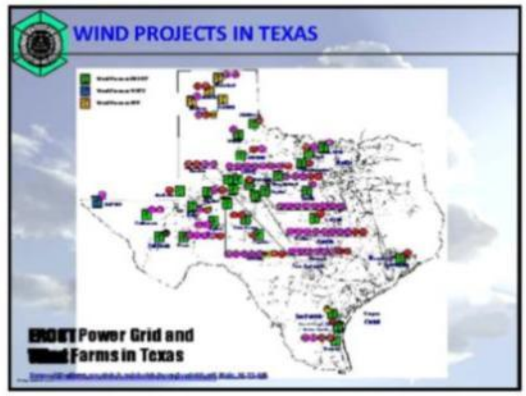
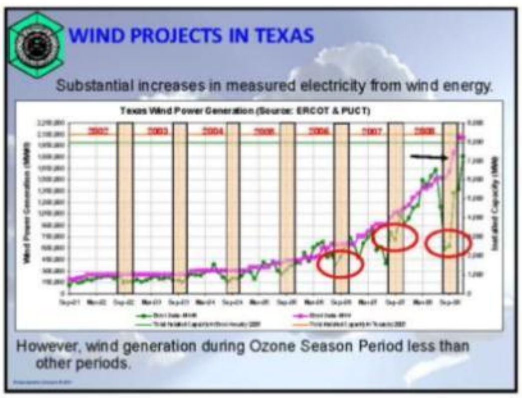
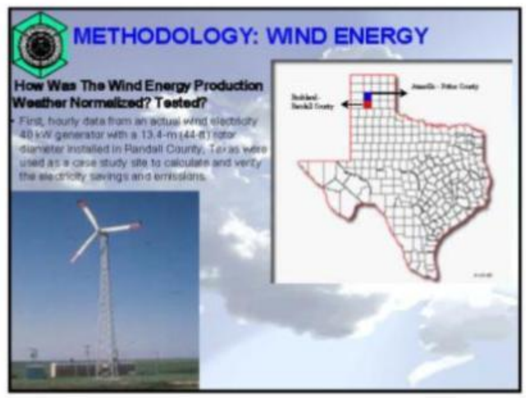
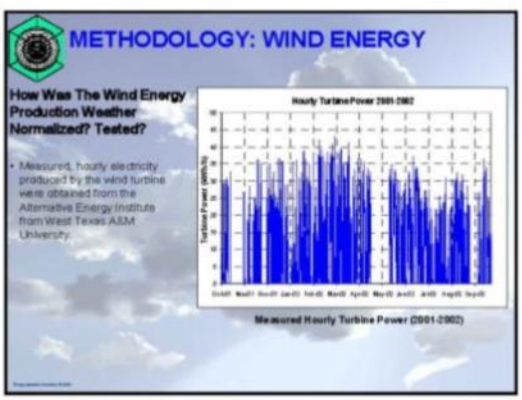


Figure 68:Presentation at CATEE Conference, Houston (October 2009) (Part 2)









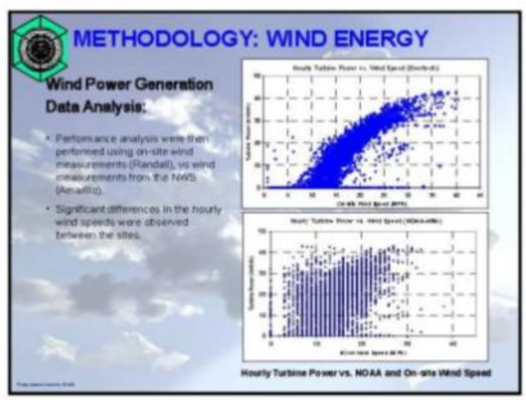
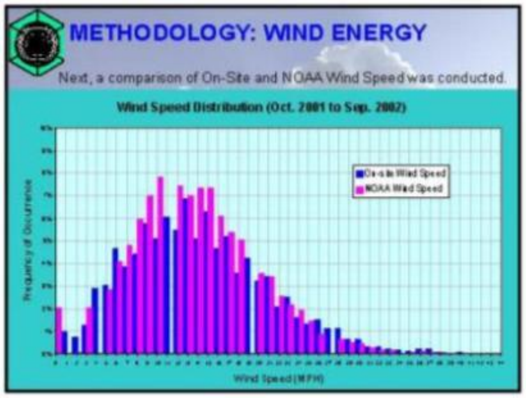
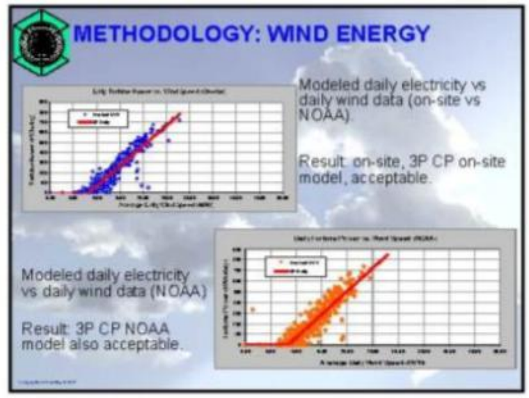
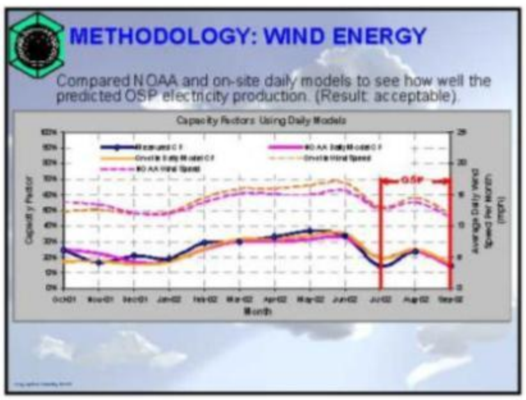
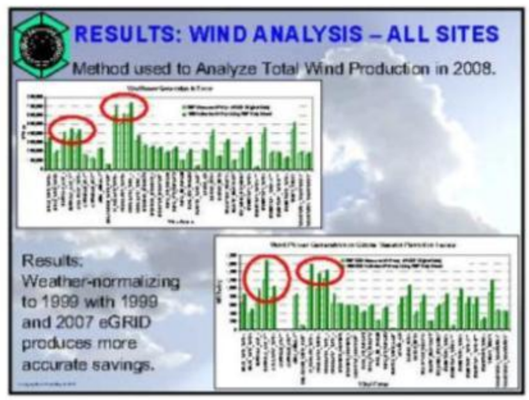


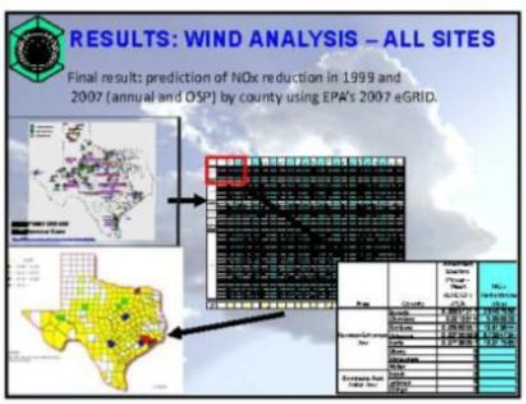
Figure 69: Presentation at CATEE Conference, Houston (October 2009) (Part 3)











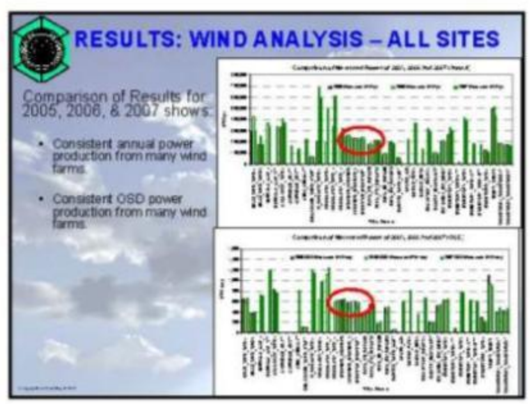
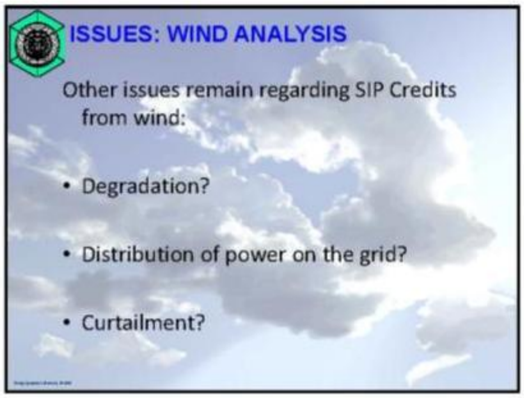
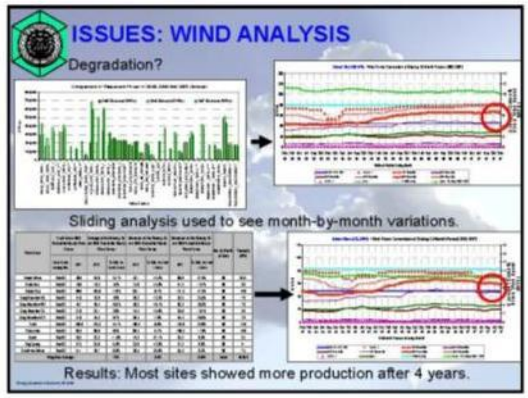
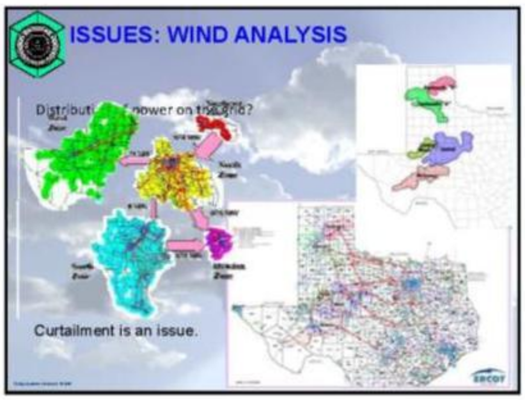
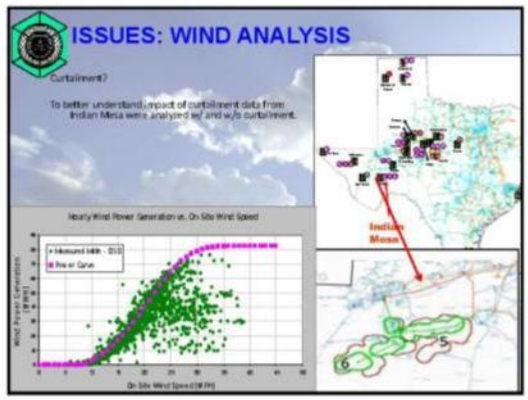


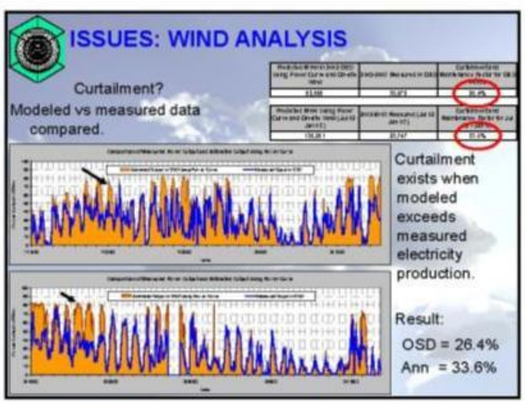
Figure 70: Presentation at CATEE Conference, Houston (October 2009) (Part 4)











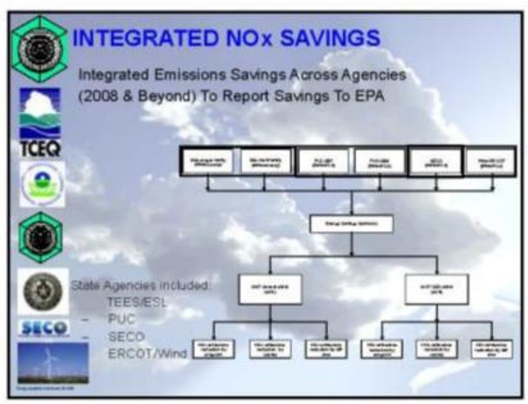
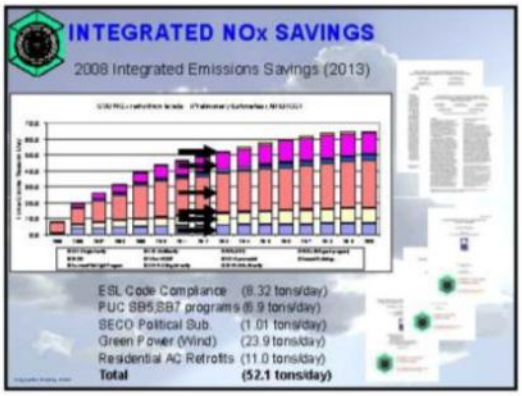


Figure 71: Presentation at CATEE Conference, Houston (October 2009) (Part 4)



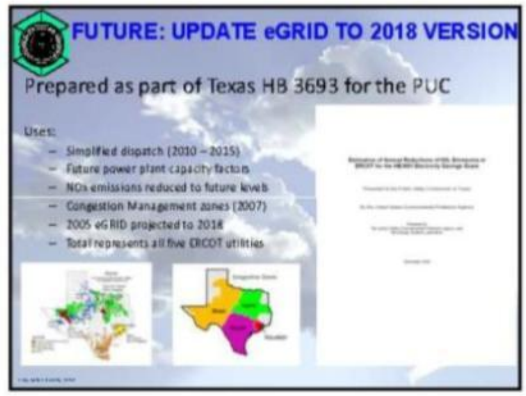


Figure 72: Presentation at CATEE Conference, Houston (October 2009) (Part 5)

5.2.7 Presented Eight Papers at the 2009 ICEBO Conference in Austin, Texas, November 2009

Eight papers were prepared and presented at the 2009 ICEBO conference in Austin, Texas in November 2009. Copies of these papers have been posted on the Laboratory's TERP web page. Titles and abstracts for each of the papers are as follows.

- Haberl, J. S., Kota, S. 2009. "Historical Survey of Daylighting Calculations Methods and Their Use in Energy Performance Simulations", *Proceedings of the Ninth International Conference for Enhanced Building Operations,* Austin, Texas, November 17-18.

This paper traces the historical development of different daylighting calculation methods. Over the years there have been several developments in daylighting calculation methods. The last two decades have seen a number of new ideas and approaches in daylight calculation procedures. Recently, selected methods have been incorporated into the building energy performance simulation tools. This paper reviews selected tools in terms of their calculation of daylighting use in buildings with an emphasis on the daylighting algorithms these tools use.

- Marshall, K., Moss, M., Malhotra, M., Liu, Z., Culp, C., Haberl, J., Herbert, C. 2009. "AIM: A Home-Owner Usable Energy Calculator for Existing Residential Homes", *Proceedings of the Ninth International Conference for Enhanced Building Operations,* Austin, Texas, November 17-18.

An energy efficiency metric for residential homes was developed to provide home-owners, realtors and builders a method to rate the energy efficiency of an existing house. To accomplish this, a web-based calculator was developed, which is based on DOE2 simulations and a simplified systems model. To simplify the use of the calculator, parameters, like window U-factor, roof/wall insulation, which are normally required for simulations in existing homes are filled using statistical tables. This allows the home-owner to use the calculator with information commonly available during a real estate transaction.

- Masuda, H., Ji, J., Baltazar, J.C., Claridge, D. 2009. "Use of First Law Energy Balance as a Screening Tool for Building Energy Use Data: Experiences on the Inclusion of Outside Air Enthalpy Variable", *Proceedings of the Ninth International Conference for Enhanced Building Operations,* Austin, Texas, November 17-18.

Quality controlled energy-use data is the foundation of energy performance evaluation for a building. The "Energy Balance Load" (*E*BL), a parameter derived from the first law of thermodynamics based on a whole-building energy analysis, has been theoretically proved to be an effective tool for verifying whole-building energy-use data (Shao and Claridge, 2006). Quality control methodology using *EBL* has been proposed and applied to more than one hundred buildings on a large university campus by Baltazar et al. (2007). They picked the outside air dry-bulb temperature (*T*OA) as the explanatory variable of *E*BL, and used a plot of *E*BL versus *T*OA, called energy balance plot, to find faulty behavior in the data by visually observing the pattern. It has been demonstrated that this methodology can detect significant data problems caused by variety of reasons such as scale factor error and mislabeled meter successfully.

This paper presents a possible enhancement on the existent *E*BL analysis technique by using the outside air enthalpy (*h*OA) as the explanatory variable of *E*BL instead of *T*OA. This enthalpy based analysis accounts for the effect of latent load on *E*BL, and therefore, may enhance the data screening capability for buildings operated at locations with hot and humid climate. Numerical threshold of data screening proposed by Masuda et al. (2008) has been applied to this enthalpy based methodology to determine the difference in the results of data screening between enthalpy based analysis and temperature based analysis.

- Christman, K., Haberl, J., Claridge, D. 2009. "Analysis of Energy Recovery Ventilator Savings for Texas Buildings", *Proceedings of the Ninth International Conference for Enhanced Building Operations*, Austin, Texas, November 17-18.

This analysis1 was conducted to identify the energy cost savings from retrofitting Texas buildings with air-to-air ERV (Energy Recovery Ventilator) systems. This analysis applied ERV and psychrometric equations in a bin-type procedure to determine the energy and costs required to condition outside air to return-air conditions. This analysis does not consider interactions with the air-handling system; therefore the effects of economizers, reheat schemes, variable flow rates and other adaptive components were not considered.

- Jones, A., Baltazar, J., Claridge, D. 2009. "Joint-Frequency Bias versus Conventional Bin Weather Data in Analysis of HVAC System Operations", *Proceedings of the Ninth International Conference for Enhanced Building Operations*, Austin, Texas, November 17-18.

Often in simplified energy analysis the use of bin weather data is employed for a more time efficient and better organized analysis than using the full 8760-hour annual weather data. It has been suggested that joint-frequency bins be used instead of conventional bin data.

Joint-frequency bins of dry bulb temperature and humidity ratio and conventional bin data are used in the analysis of the operation of four different HVAC systems in a prototype building using weather data from four climatic regions. In the case of 10% ventilation air, the analysis shows less than 3% difference in cooling between the use of the different bin methods. An increase of ventilation air to 40% increases the percent difference up to 10% difference in cooling requirements. From this study the use of joint-frequency bins has relative added value to the analysis of HVAC system operation depending on whether the system is dominated by ventilation loads.

- Mukhopadhyay, J., Liu, Z., Malhotra, M., Kota, S., Blake, S., Haberl, J., Culp, C., Yazdani, B. 2009. "Recommendations for 15% Above-Code Energy Efficiency Measures on Implementing Houston Amendments to Single-Family Residential Buildings in Houston, Texas", *Proceedings of the Ninth International Conference for Enhanced Building Operations*, Austin, Texas, November 17-18.

This paper presents information about the energy saving potential for single-family residential buildings in Houston, Texas that are designed to be 15% above code. The energy efficient measures discussed in this paper were proposed by the building officials of the City of Houston. Along with the options proposed by the officials, additional measures were selected from the 15% above code energy analysis previously conducted by the Energy Systems Laboratory for residential houses across the State of Texas. In this analysis a total of thirty-one measures were analyzed based on the energy savings above a base-case, code-compliant house. These measures were categorized into five groups: Renewable Energy options, Heating Ventilation and Air Conditioning (HVAC), Fenestration, Envelope, Lighting and Domestic Hot Water (DHW) options. The analysis was performed using an hourly simulation of an International Energy Conservation Code (IECC)-compliant, single family residence in Houston, Texas. Four sets of simulations were performed based on the choice of heating fuel type and thermostat setback.

Individual measures were then categorized into four groups: 2 to 5%, 5 to 10%, and 10 to 15% and above 15% energy savings. Ten groups were then simulated by combining individual measures from the four categories whose combined savings are more than 15% above the base case. The cost of the implementation of the individual, as well as group measures was also calculated along with simple payback period. Photovoltaic options presented the maximum savings in the approximate range of 15-40% for all base-case houses depending on the size of the installed array. The solar thermal option for domestic water heating showed a savings above 15-20% for all the base-case houses.

- Mukhopadhyay, J., Liu, Z., Malhotra, M., Kota, S., Blake, S., Haberl, J., Culp, C., Yazdani, B. 2009. "Recommendations for 15% Above-Code Energy Efficiency Measures on Implementing Houston Amendments to Multifamily Residential Buildings in Houston, Texas", *Proceedings of the Ninth International Conference for Enhanced Building Operations*, Austin, Texas, November 17-18.

This paper presents results from an analysis of the energy saving potential for multifamily residential buildings in Houston. In this analysis, the energy efficient measures were proposed by the building officials with the City of Houston and analyzed by the Energy Systems Laboratory using a code-compliant calculator. Along with the options proposed by the officials, additional measures were selected from the 15% above code energy analysis conducted by the Energy Systems Laboratory for residential houses across the State of Texas. A total of 16 measures based on their energy savings above a code-compliant residence were selected. These measures were categorized into five groups: renewable power options, heating ventilation and air conditioning (HVAC), fenestration, envelope, lighting and domestic hot water (DHW) options. The analysis was performed using a simulation model of an International Energy Conservation Code (IECC 2000 with 2001 supplement)-compliant, single-family residence in Houston, Texas. Two sets of simulations based on the choice of heating fuel type were considered.

Individual measures were then categorized into 3 groups: 2 to 5%, 5 to 10%, and above 10% energy savings above base case. Individual measures from the three categories were then chosen to form group measures whose combined energy savings is above 15%. Six group measures were simulated for the electric/gas base case building and five group measures for the all-electric base case building. The cost of implementing the individual measures was also calculated along with simple payback period.

- Kim, S., Haberl, J., Liu, Z. 2009. “Development of DOE-2 Based Simulation Models for the Code-Compliant Commercial Consturction Based on the ASHRAE Standard 90.1”, *Proceedings of the Ninth International Conference for Enhanced Building Operations*, Austin, Texas, November 17-18.

In 2001, the Texas State Senate passed Senate Bill 5 to reduce ozone levels by encouraging the reduction of emissions of NOx that were not regulated by the Texas Natural Resource Conservation Commission. These include point sources (power plants), area sources (such as residential emissions), road mobile sources, and non-road mobile sources. For the building energy sector, the Texas State Legislature adopted the 2000 International Energy Conservation Code, as modified by the 2001 Supplement, as the state’s building energy code. The 2000/2001 IECC is a comprehensive energy conservation code that establishes a standard for the insulation levels, glazing, cooling and heating system efficiencies through the use of prescriptive and performance-based provisions.

This paper provides a detailed description of the procedures that were developed to calculate the electricity and natural gas savings in new office construction that is being built in compliance with Chapter 8 of the 2000/2001 International Energy Conservation Code. Since most of the commercial portion of the 2000/2001 International Energy Conservation Code refers to ASHRAE Standard 90.1-1999 as the current code requirement for commercial construction, the simulation models based on the ASHRAE Standard 90.1, with general commercial configurations, are created to quantify the electricity and gas savings. Then, simulation models are modified to accommodate the different scenarios of construction and HVAC equipment based on three different codes (i.e., ASHRAE Standard 90.1-1989 (pre-code), 1999 (code-compliant), and 2004 (new-code)). The “pre-code” designation is meant to represent the commercial construction characteristics before the passage of Texas Emission Reduction Plan (TERP) in September 2001. In the simulations, “pre-code”, “code-complaint” and “new code” represent the commercial constructions in compliance with ASHRAE Standard 90.1-1989, ASHRAE Standard 90.1-1999, and ASHRAE Standard 90.1-2004, respectively.

This paper includes an explanation of the simulation models developed for the different versions of ASHRAE Standard 90.1, as mentioned above, which are used for investigating the electricity and gas energy savings.

6 Calculated NOx Reduction Potential From Implementation of the IECC/IRC

6.1 Calculated 2009 Electricity and Natural Gas Savings Due to the Implementation of the IECC/IRC to New Residential Construction (Single-family and Multi-family), and Commercial Buildings Using Code-traceable, Fuel-Neutral Simulation.

A complete reporting of the savings from the implementation of the IECC/IRC requires tracking and analyzing savings to new construction and construction activity to existing buildings that undergoes a building permit. Adoption of the IECC/IRC is expected to impact the following types of buildings:

- single-family residential
- multi-family residential
- commercial buildings
- industrial buildings
- renewables

Adoption of the IECC/IRC is also expected to impact construction activity in existing buildings that undergoes a building permit. Such activity would impact the following types of buildings:

- single-family residential
- multi-family residential
- commercial buildings
- industrial buildings
- renewables

The following sections report calculations of the energy savings associated only with new construction activity in new residences (i.e., single-family and multi-family), and commercial construction. Calculation of energy savings adoption of the IECC/IRC in industrial building and renewables is currently under development at the Laboratory, and will be reported in future reports.

6.1.1 2009 Results for New Single-family Residential Construction

In this section of the report, calculations are provided regarding the potential electricity reductions and associated emissions reductions from the implementation of the IECC/IRC to new single-family residences in the 41 non-attainment and affected counties as well as other counties in the ERCOT region[17]. To calculate the NOx emissions reductions from the implementation of the IECC/IRC, a number of procedures were followed. First, new construction activity by county had to be determined, then energy savings attributable to the IECC/IRC had to be modeled using the code-traceable, DOE-2 simulation that the Laboratory has developed for the TERP. These estimates were then applied to the NAHB Builder's survey data to determine the appropriate number of housing types. Then estimates of the NOx reduction potential from the electricity reductions in each county were calculated using the US EPA's 2007 eGRID database[18].

In Table 2 and Table 3, the 1999 and IECC/IRC code-compliant building characteristics are shown for each county. The 1999 building characteristics reflect those published by the NAHB, ARI and GAMA for Texas. The IECC/IRC code-compliant characteristics are the minimum building code characteristics required by the IECC/IRC for each county for single-family residences (i.e., Type A.1)[19]. In Table 2 and Table 3 the rows are sorted first by the US EPA's non-attainment, affected designation, and other ERCOT Counties, then alphabetically. Next, in the third column, the NAHB survey classification is listed. The fourth column in Table 2 and Table 3 lists the window area for the average house as defined by the NAHB

[17] The three new counties, Henderson, Hood and Hunt were added in the 2003 Legislative session are included in this.

[18] This preliminary analysis does not include actual power transfers on the grid, and assumes transmission and distribution losses of 7%. Counties were assigned to utility service districts as indicated.

[19] As modified by the 2001 Supplement.

survey[20]. The fifth, sixth, seventh, eighth, and ninth columns show the NAHB's average glazing U-value, Solar Heat Gain Coefficient (SHGC), roof insulation and wall insulation, respectively. In columns nine through thirteen of Table 2 and Table 3, the corresponding values from the IECC / IRC code-compliant house are listed for each county (i.e., percent area, glazing U-value, SHGC, roof and wall insulation R-value). For each county, the identical window percent area was used for the 1999 and code-compliant calculation (i.e., window-to-wall area).

The IECC/IRC SHGC is 0.4 for all non-attainment and affected counties since they all fall below the 3,500 HDD_{65}, as required by the IECC/IRC. All the 1999 houses were assumed to have an air-conditioner efficiency[21] equal to a SEER 11, a furnace efficiency (AFUE) of 0.80, and a domestic water heater efficiency of 76%. All the IECC/IRC code-compliant houses were assumed to have an air-conditioner efficiency equal to a SEER 13[22]. The values shown in Table 2 and Table 3 represent the only changes that were made to the simulation to obtain the savings calculations. All other variables in the simulation remained the same for the 1999 and IECC/IRC code-compliant simulation. In cases where the 1999 values were more efficient than the IECC/IRC code-compliant simulation, the 1999 values were used in both simulations, since this indicates that the prevailing practice is already above code. For example, in Brazoria County, according to the NAHB, the roof insulation is R-27.08, which is already above the code-required insulation of R-19. Therefore, R-27.08 was used in both simulations.

The code-traceable simulation results are shown for each county. In a similar fashion as Table 2 and Table 3, Table 4 and Table 5 is first divided into US EPA affected and then non-attainment classifications, followed by an alphabetical listing of counties. In the third column, the IECC/IRC climate zone is listed followed by the number of projected new housing units[23] in the fourth column. In the fifth column, the total simulated energy use is listed if all new construction had been built to pre-code specifications, and, in the sixth column, the total county-wide energy use for code-compliant construction is shown.

The values in the fifth and sixth columns come from the associated tables in the 2007 Volume III Appendix, which remain the same as the 2006 listing, 24 simulations were run for each county, which were then distributed according to the NAHB's survey data to account for 1 story, 2 story, slab-on-grade, crawlspace, and three different system types. In the seventh and eighth columns, the total pre-code and code-compliant peak OSD energy use is reported for the Ozone Season Day across all counties[24]. In a similar fashion as the annual pre-code and code-compliant energy use, these values are from the associated tables for each county in the Volume III Appendix to this report for the 1999 peak OSD results.

In the ninth and tenth columns, the total annual electricity and peak OSD savings are shown for each county, respectively. A 7% transmission and distribution loss is used in the 2007 report, which represents a fixed 1.07 multiplier for the electricity use. In the eleventh and twelfth columns, the total annual pre-code and code-compliant natural gas use is shown for those residences that had natural gas-fired furnaces and domestic water heaters. Similarly, in columns thirteen and fourteen, the simulated total peak OSD natural gas use on the peak Ozone Season Day (OSD) is shown for each county. Finally, in columns fifteen and sixteen, the total annual and peak OSD natural gas savings are shown for each county.

In Table 6 and Table 7 the 2006 and 2007 PCA assignments for each county are shown. These assignments are the same with the assignments used in the 2006 annual report. These assignments were expanded from the 2005 report because all ERCOT counties are shown in the 2006 report. In Table 8, the annual electricity

[20] This value represents the NAHB's reported number of window units times an average window size of 3 x 5 feet, which was determined by surveying local building suppliers. Additional information about the procedures used to determine these values can be found in the MS Thesis by Im (2003).
[21] The choice of a SEER 11 efficiency for the air conditioner was based on ARI sales numbers for Texas which show an average SEER 11 for houses built in 1999.
[22] Based on the regulation effective ….
[23] The number of projected new housing units uses the published values for the new housing units in 2006. A vacancy rate of 0% was assumed for 2007 calculations, based on information suggested by the Real Estate Center at Texas A&M University.
[24] In the 2005 report, the peak Ozone Season Day (OSD) was used to report peak savings. This is different than the peak day for 2004, which was August 19, 1999. This change was made at the request of the TCEQ. In the 2002 and 2003 reports, these dates represent the TMY2 non-coincident dates that were chosen by the DOE-2 simulation program as the peak date for the houses simulated in a specific county. Hence, the 2002 and 2003 dates did not correspond to the same calendar date.

savings are assigned to PCA provider(s) according to Table 6 and Table 7. The total electricity savings for each PCA, as shown in then entered into the bottom row of Table 8 and Table 10, which is the 2007 US EPA eGRID database for Texas. eGRID then proportions each MWh of electricity savings according to the 1999 measured data from the power plants assigned to that PCA. For each county in which there is a power plant the lbs-NOx/MWh are calculated and displayed as NOx reductions (lbs) in the column adjacent to the PCA column. Adding across the rows then totals the NOx reductions in each county from multiple PCAs that have power plants in that county. Counties that do not show NOx reductions represent counties that do not have power plants in eGRID's database. In Table 10 the PCA assignments for peak reductions are shown for each county; and in the peak OSD NOx reductions are shown calculated with eGRID.

Table 2: 1999 and IECC/IRC Code-complaint Building Characteristics used in the DOE-2 Simulator for Single-family Residential (1)

	County	Climate Zone	Division	1999 Average					2000 IECC				
			(East or West)	Area %	Glazing U-value (Btu/ hr-ft2-F)	SHGC	Roof Insulation (hr-ft2-F/Btu)	Wall Insulation (hr-ft2-F/Btu)	Area %	Glazing U-value (Btu/ hr-ft2-F)	SHGC	Roof Insulation (hr-ft2-F/Btu)	Wall Insulation (hr-ft2-F/Btu)
	BRAZORIA	3	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	19.00	11.00
	CHAMBERS	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	COLLIN	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	DALLAS	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	DENTON	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	EL PASO	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	FORT BEND	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
Non-attainment	GALVESTON	3	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	19.00	11.00
	HARDIN	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	HARRIS	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	JEFFERSON	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	LIBERTY	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	MONTGOMERY	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	ORANGE	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	TARRANT	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	WALLER	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	BASTROP	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	BEXAR	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	CALDWELL	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	COMAL	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	ELLIS	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	GREGG	6	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	GUADALUPE	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	HARRISON	6	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	HAYS	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	HENDERSON	5	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.65	0.40	30.00	13.00
	HOOD	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	HUNT	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
Affected	JOHNSON	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	KAUFMAN	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	NUECES	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	PARKER	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	ROCKWALL	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	RUSK	5	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.65	0.40	30.00	13.00
	SAN PATRICIO	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	SMITH	5	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.65	0.40	30.00	13.00
	TRAVIS	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	UPSHUR	6	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	VICTORIA	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	WILLIAMSON	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	WILSON	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	ANDERSON	5	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.65	0.40	30.00	13.00
	ANDREWS	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	ANGELINA	5	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.65	0.40	30.00	13.00
	ARANSAS	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	ARCHER	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	ATASCOSA	3	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	AUSTIN	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	BANDERA	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	BAYLOR	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	BEE	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	BELL	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	BLANCO	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	BORDEN	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	BOSQUE	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	BRAZOS	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	BREWSTER	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	BRISCOE	8	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.41	0.40	38.00	19.00
	BROOKS	2	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.90	0.40	19.00	11.00
	BROWN	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	BURLESON	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	BURNET	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	CALHOUN	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	CALLAHAN	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	CAMERON	2	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.90	0.40	19.00	11.00
	CHEROKEE	5	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.65	0.40	30.00	13.00
	CHILDRESS	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	CLAY	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
ERCOT	COKE	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	COLEMAN	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	COLORADO	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	COMANCHE	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	CONCHO	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	COOKE	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	CORYELL	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	COTTLE	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	CRANE	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	CROCKETT	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	CROSBY	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	CULBERSON	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	DAWSON	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	DE WITT	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	DELTA	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	DICKENS	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	DIMMIT	3	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	DUVAL	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	EASTLAND	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	ECTOR	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	EDWARDS	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	ERATH	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	FALLS	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	FANNIN	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	FAYETTE	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	FISHER	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	FOARD	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	FRANKLIN	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	FREESTONE	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00

Table 3: 1999 and IECC/IRC Code-compliant Characteristics used in the DOE-2 Simulator for Single-family Residential (2)

	County	Climate Zone	Division	1999 Average					2000 IECC				
			(East or West)	Area %	Glazing U-value (Btu/ hr-ft2-F)	SHGC	Roof Insulation (hr-ft2-F/Btu)	Wall Insulation (hr-ft2-F/Btu)	Area %	Glazing U-value (Btu/ hr-ft2-F)	SHGC	Roof Insulation (hr-ft2-F/Btu)	Wall Insulation (hr-ft2-F/Btu)
	FRIO	3	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	GILLESPIE	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	GLASSCOCK	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	GOLIAD	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	GONZALES	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	GRAYSON	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	GRIMES	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	HALL	8	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.41	0.40	38.00	19.00
	HAMILTON	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	HARDEMAN	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	HASKELL	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	HIDALGO	2	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.90	0.40	19.00	11.00
	HILL	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	HOPKINS	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	HOUSTON	5	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.65	0.40	30.00	13.00
	HOWARD	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	HUDSPETH	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	IRION	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	JACK	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	JACKSON	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	JEFF DAVIS	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	JIM HOGG	2	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	JIM WELLS	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	JONES	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	KARNES	3	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	KENDALL	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	KENEDY	2	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.90	0.40	19.00	11.00
	KENT	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	KERR	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	KIMBLE	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	KING	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	KINNEY	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	KLEBERG	2	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.90	0.40	19.00	11.00
	KNOX	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	LA SALLE	3	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	LAMAR	6	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	LAMPASAS	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	LAVACA	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	LEE	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	LEON	5	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.65	0.40	30.00	13.00
	LIMESTONE	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	LIVE OAK	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	LLANO	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	LOVING	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	MADISON	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	MARTIN	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	MASON	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	MATAGORDA	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	MAVERICK	3	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	MCCULLOCH	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	MCLENNAN	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	MCMULLEN	3	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
ERCOT	MEDINA	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	MENARD	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	MIDLAND	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	MILAM	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	MILLS	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	MITCHELL	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	MONTAGUE	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	MOTLEY	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	NACOGDOCHES	5	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.65	0.40	30.00	13.00
	NAVARRO	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	NOLAN	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	PALO PINTO	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	PECOS	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	PRESIDIO	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	RAINS	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	REAGAN	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	REAL	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	RED RIVER	6	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	REEVES	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	REFUGIO	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	ROBERTSON	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	RUNNELS	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	SAN SABA	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	SCHLEICHER	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	SCURRY	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	SHACKELFORD	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	SOMERVELL	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	STARR	2	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.90	0.40	19.00	11.00
	STEPHENS	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	STERLING	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	STONEWALL	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	SUTTON	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	TAYLOR	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	TERRELL	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	THROCKMORTON	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	TITUS	6	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	TOM GREEN	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	UPTON	5	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.50	0.40	38.00	13.00
	UVALDE	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	VAL VERDE	4	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.52	0.40	30.00	13.00
	VAN ZANDT	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	WARD	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	WASHINGTON	4	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.75	0.40	26.00	13.00
	WEBB	3	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	WHARTON	3	East Texas	13.8	1.11	0.71	27.08	14.18	13.8	0.75	0.40	19.00	11.00
	WICHITA	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	WILBARGER	7	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.45	0.40	38.00	19.00
	WILLACY	2	East Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.90	0.40	19.00	11.00
	WINKLER	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	WISE	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	YOUNG	6	West Texas	20.6	0.87	0.66	26.75	14.18	20.6	0.46	0.40	38.00	16.00
	ZAPATA	2	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00
	ZAVALA	3	West Texas	13.8	1.11	0.71	27.08	13.99	13.8	0.60	0.40	30.00	13.00

Table 4: 2009 Annual and Peak-day Electricity Savings from Implementation of the IECC/IRC for Single-family Residences Using 1999 Base Year (1)

2009 Summary TRY 1999															
	County	Climate Zone	No. of Projected Units (2006)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Precode OSD Elec. Use (MWh/day)	Code-compliant OSD Elec. Use (MWh/day)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Total OSD Elec. Savings (MWh/day) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Precode OSD NG Use (Therm/day)	Code-compliant OSD NG Use (Therm/day)	Total Annual NG Savings (Therm/yr)	Total OSD NG Savings (Therm/day)
	BASTROP	4	23	383	355	1.76	1.57	**29**	**0.21**	5,491	5,287	8.76	8.33	**204**	**0.43**
	BEXAR	4	3,625	55,406	51,771	249.39	223.29	**3,890**	**27.93**	1,056,129	1,016,474	1,538.99	1,465.82	**39,656**	**73.17**
	CALDWELL	4	20	325	301	1.52	1.35	**25**	**0.18**	5,179	4,984	8.31	7.91	**194**	**0.40**
	COMAL	4	826	12,625	11,797	56.83	50.88	**886**	**6.36**	240,652	231,616	350.68	334.01	**9,036**	**16.67**
	ELLIS	5	475	7,949	7,406	38.12	33.88	**582**	**4.53**	199,099	192,084	192.06	182.47	**7,015**	**9.59**
	GREGG	6	157	2,448	2,312	10.91	9.83	**145**	**1.15**	52,068	49,186	58.20	55.29	**2,882**	**2.91**
	GUADALUPE	4	813	12,426	11,611	55.93	50.08	**872**	**6.26**	236,864	227,971	345.16	328.75	**8,894**	**16.41**
	HARRISON	6	41	637	602	2.82	2.55	**37**	**0.30**	13,755	13,001	15.20	14.44	**755**	**0.76**
	HAYS	5	1,009	16,390	15,188	76.65	68.07	**1,285**	**9.18**	260,814	251,078	419.18	398.81	**9,736**	**20.37**
	HENDERSON	5	50	775	732	3.43	3.09	**45**	**0.36**	16,829	15,932	18.53	17.61	**897**	**0.93**
	HOOD	5	41	686	639	3.29	2.92	**50**	**0.39**	17,185	16,580	16.58	15.75	**606**	**0.83**
	HUNT	6	46	771	718	3.69	3.28	**56**	**0.44**	19,338	18,662	18.60	17.67	**676**	**0.93**
Affected County	JOHNSON	5	515	8,619	8,029	41.33	36.74	**631**	**4.91**	215,865	208,259	208.23	197.84	**7,606**	**10.39**
	KAUFMAN	6	136	2,283	2,137	10.94	9.76	**157**	**1.26**	57,057	54,202	54.99	52.24	**2,855**	**2.75**
	NUECES	3	793	12,377	11,506	50.01	44.81	**931**	**5.57**	157,091	150,938	310.48	295.81	**6,153**	**14.67**
	PARKER	6	334	5,608	5,247	26.87	23.98	**385**	**3.10**	140,126	133,114	135.05	128.31	**7,012**	**6.74**
	ROCKWALL	6	545	9,150	8,562	43.84	39.12	**629**	**5.05**	228,648	217,207	220.36	209.36	**11,442**	**11.00**
	RUSK	5	6	85	80	0.35	0.32	**5**	**0.04**	1,976	1,906	2.43	2.32	**70**	**0.11**
	SAN PATRICIO	3	159	2,482	2,307	10.03	8.98	**187**	**1.12**	31,498	30,264	62.25	59.31	**1,234**	**2.94**
	SMITH	5	160	2,480	2,340	10.98	9.88	**150**	**1.17**	53,852	51,437	59.31	56.35	**2,415**	**2.96**
	TRAVIS	5	3,661	59,468	55,109	278.10	246.98	**4,664**	**33.30**	946,322	910,996	1,520.92	1,447.03	**35,326**	**73.89**
	UPSHUR	6	8	140	131	0.65	0.58	**9**	**0.07**	3,113	2,946	2.97	2.82	**166**	**0.15**
	VICTORIA	3	46	652	615	2.72	2.45	**41**	**0.29**	10,795	10,401	18.45	17.60	**394**	**0.85**
	WILLIAMSON	5	1,965	31,919	29,579	149.27	132.56	**2,503**	**17.87**	507,927	488,967	816.34	776.68	**18,961**	**39.66**
	WILSON	4	27	413	386	1.86	1.66	**29**	**0.21**	7,866	7,571	11.46	10.92	**295**	**0.54**
	BRAZORIA	3	1,496	22,179	20,754	94.40	84.52	**1,525**	**10.57**	328,691	315,930	577.25	549.57	**12,761**	**27.68**
	CHAMBERS	4	257	3,816	3,572	16.09	14.42	**261**	**1.78**	57,014	54,822	100.96	96.21	**2,192**	**4.76**
	COLLIN	6	3,392	56,949	53,039	272.87	242.54	**4,183**	**32.45**	1,423,073	1,373,258	1,371.50	1,303.03	**49,815**	**68.46**
	DALLAS	5	2,701	45,203	42,111	216.74	192.67	**3,308**	**25.75**	1,132,139	1,092,249	1,092.10	1,037.59	**39,889**	**54.52**
	DENTON	6	2,469	41,453	38,790	198.62	177.23	**2,849**	**22.88**	1,035,840	984,006	998.30	948.46	**51,834**	**49.83**
	EL PASO	6	2,640	40,177	38,133	152.77	140.06	**2,188**	**13.60**	1,025,169	968,218	1,161.81	1,108.52	**56,951**	**53.29**
	FORT BEND	4	4,845	71,884	67,260	306.08	274.02	**4,948**	**34.31**	1,064,512	1,023,040	1,869.50	1,779.84	**41,472**	**89.65**
Nonattainment County	GALVESTON	3	1,140	16,901	15,815	71.94	64.41	**1,162**	**8.06**	250,473	240,749	439.88	418.79	**9,725**	**21.09**
	HARDIN	4	126	1,873	1,753	7.90	7.08	**129**	**0.87**	27,953	26,880	49.50	47.17	**1,072**	**2.33**
	HARRIS	4	11,591	171,973	160,910	732	656	**11,837**	**82.08**	2,546,700	2,447,482	4,472.51	4,258.03	**99,217**	**214.48**
	JEFFERSON	4	1,205	17,919	16,770	76	68	**1,230**	**8.37**	267,324	257,069	473.38	451.08	**10,255**	**22.30**
	LIBERTY	4	231	3,431	3,210	15	13	**237**	**1.64**	50,747	48,777	89.13	84.86	**1,971**	**4.27**
	MONTGOMERY	4	2,773	41,142	38,496	175.18	156.83	**2,832**	**19.64**	609,266	585,529	1,069.99	1,018.68	**23,736**	**51.31**
	ORANGE	4	319	4,743	4,439	20	18	**325**	**2.22**	70,769	68,054	125.32	119.42	**2,715**	**5.90**
	TARRANT	5	4,465	74,725	69,614	358	319	**5,468**	**42.57**	1,871,529	1,805,588	1,805.35	1,715.22	**65,941**	**90.12**
	WALLER	4	6	89	83	0.38	0.34	**6**	**0.04**	1,318	1,267	2.32	2.20	**51**	**0.11**
	ANDERSON	5	13	184	174	0.76	0.68	**10**	**0.08**	4,281	4,131	5.27	5.03	**151**	**0.24**
	ANDREWS	6	46	677	594	2.64	2.17	**89**	**0.50**	23,164	21,664	21.46	20.54	**1,500**	**0.93**
	ANGELINA	5	52	735	697	3.02	2.73	**40**	**0.31**	17,125	16,522	21.07	20.11	**603**	**0.96**
	ARANSAS	3	97	1,514	1,407	6.12	5.48	**114**	**0.68**	19,215	18,463	37.98	36.18	**753**	**1.79**
	ARCHER	7	9	150	130	0.68	0.54	**22**	**0.14**	5,378	4,844	3.99	3.81	**535**	**0.18**
	ATASCOSA	3	32	476	416	2.20	1.80	**64**	**0.42**	8,532	8,474	13.41	12.76	**59**	**0.65**
	AUSTIN	4	30	445	416	1.90	1.70	**31**	**0.21**	6,591	6,335	11.58	11.02	**257**	**0.56**
	BANDERA	5	1	15	13	0.07	0.06	**2**	**0.01**	266	253	0.42	0.40	**13**	**0.02**
	BAYLOR	7	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	BEE	3	4	57	53	0.24	0.21	**4**	**0.02**	939	904	1.60	1.53	**34**	**0.07**
	BELL	5	1,841	30,213	25,902	147.84	117.95	**4,613**	**31.98**	762,865	740,063	809.58	772.42	**22,802**	**37.16**
	BLANCO	5	7	114	105	0.53	0.47	**9**	**0.06**	1,809	1,742	2.91	2.77	**68**	**0.14**
	BORDEN	7	19	283	252	0.97	0.81	**33**	**0.17**	11,894	10,689	8.55	8.20	**1,205**	**0.35**
	BOSQUE	5	4	66	56	0.32	0.26	**10**	**0.07**	1,658	1,608	1.76	1.68	**50**	**0.08**
	BRAZOS	4	707	10,490	9,815	44.66	39.99	**722**	**5.01**	155,337	149,286	272.80	259.72	**6,052**	**13.08**
	BREWSTER	5	20	306	266	1.27	1.03	**43**	**0.26**	10,152	9,851	8.89	8.49	**301**	**0.40**
	BRISCOE	8	7	102	92	0.31	0.27	**11**	**0.04**	6,943	5,889	3.58	3.44	**1,054**	**0.14**
	BROOKS	2	4	69	59	0.30	0.25	**11**	**0.06**	777	765	1.50	1.43	**12**	**0.07**
	BROWN	5	108	1,772	1,520	8.67	6.92	**271**	**1.88**	44,753	43,415	47.49	45.31	**1,338**	**2.18**
	BURLESON	4	12	178	167	0.76	0.68	**12**	**0.08**	2,637	2,534	4.63	4.41	**103**	**0.22**
	BURNET	5	235	3,817	3,537	17.85	15.85	**299**	**2.14**	60,744	58,477	97.63	92.89	**2,268**	**4.74**
	CALHOUN	3	60	851	802	3.55	3.20	**53**	**0.37**	14,080	13,567	24.06	22.95	**514**	**1.11**
	CALLAHAN	6	12	189	165	0.82	0.66	**26**	**0.16**	6,325	5,875	5.40	5.16	**449**	**0.24**
	CAMERON	2	939	16,223	13,910	70.97	58.38	**2,475**	**13.47**	182,421	179,616	352.23	334.86	**2,805**	**17.38**
	CHEROKEE	5	10	141	134	0.58	0.53	**8**	**0.06**	3,293	3,177	4.05	3.87	**116**	**0.19**
	CHILDRESS	7	6	90	80	0.31	0.25	**11**	**0.05**	3,756	3,376	2.70	2.59	**380**	**0.11**
	CLAY	7	2	33	29	0.15	0.12	**5**	**0.03**	1,195	1,076	0.89	0.85	**119**	**0.04**
	COKE	6	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
ERCOT	COLEMAN	5	1	16	14	0.07	0.05	**2**	**0.01**	529	514	0.45	0.43	**15**	**0.02**
	COLORADO	4	12	178	167	0.76	0.68	**12**	**0.08**	2,637	2,534	4.63	4.41	**103**	**0.22**
	COMANCHE	5	3	49	42	0.24	0.19	**8**	**0.05**	1,243	1,206	1.32	1.26	**37**	**0.06**
	CONCHO	5	1	15	13	0.06	0.05	**2**	**0.01**	508	493	0.44	0.42	**15**	**0.02**
	COOKE	6	28	469	437	2.25	2.00	**34**	**0.27**	11,771	11,359	11.32	10.76	**411**	**0.57**
	CORYELL	5	166	2,724	2,336	13.33	10.64	**416**	**2.88**	68,786	66,730	73.00	69.65	**2,056**	**3.35**
	COTTLE	7	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	CRANE	5	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	CROCKETT	5	19	290	252	1.21	0.98	**41**	**0.25**	9,644	9,358	8.45	8.07	**286**	**0.38**
	CROSBY	7	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	CULBERSON	6	9	127	111	0.50	0.42	**17**	**0.09**	3,144	2,952	4.00	3.82	**192**	**0.18**
	DAWSON	7	6	90	80	0.31	0.25	**11**	**0.05**	3,756	3,376	2.70	2.59	**380**	**0.11**
	DE WITT	3	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	DELTA	6	6	101	94	0.48	0.43	**7**	**0.06**	2,517	2,429	2.43	2.30	**88**	**0.12**
	DICKENS	7	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	DIMMIT	3	7	123	103	0.55	0.44	**21**	**0.11**	1,408	1,372	2.89	2.75	**36**	**0.14**
	DUVAL	3	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	EASTLAND	6	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	ECTOR	6	220	3,239	2,841	12.64	10.40	**425**	**2.40**	110,784	103,611	102.66	98.22	**7,173**	**4.44**
	EDWARDS	5	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	ERATH	6	31	489	425	2.11	1.71	**68**	**0.42**	16,338	15,178	13.96	13.34	**1,160**	**0.63**
	FALLS	5	4	66	56	0.32	0.26	**10**	**0.07**	1,658	1,608	1.76	1.68	**50**	**0.08**
	FANNIN	6	11	184	172	0.88	0.78	**14**	**0.10**	4,624	4,463	4.45	4.23	**162**	**0.22**
	FAYETTE	4	5	74	69	0.32	0.28	**5**	**0.04**	1,099	1,056	1.93	1.84	**43**	**0.09**
	FISHER	6	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	FOARD	7	0	0	0	0.00	0.00	**0**	**0.00**	0	0	0.00	0.00	**0**	**0.00**
	FRANKLIN	6	2	34	31	0.16	0.14	**2**	**0.02**	839	810	0.81	0.77	**29**	**0.04**
	FREESTONE	5	5	82	70	0.40	0.32	**13**	**0.09**	2,072	2,010	2.20	2.10	**62**	**0.10**
	FRIO	3	12	178	156	0.82	0.68	**24**	**0.16**	3,200	3,178	5.03	4.79	**22**	**0.24**

Table 5: 2009 Annual and Peak-day Electricity Savings from Implementation of the IECC/IRC for Single-family Residences Using 1999 Base Year (2)

2009 Summary TRY 1999															
	County	Climate Zone	No. of Projected Units (2006)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Precode OSD Elec. Use (MWh/day)	Code-compliant OSD Elec. Use (MWh/day)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Total OSD Elec. Savings (MWh/day) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Precode OSD NG Use (Therm/day)	Code-compliant OSD NG Use (Therm/day)	Total Annual NG Savings (Therm/yr)	Total OSD NG Savings (Therm/day)
	GILLESPIE	5	28	455	421	2.13	1.89	36	0.25	7,238	6,967	11.63	11.07	270	0.57
	GLASSCOCK	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	GOLIAD	3	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	GONZALES	4	1	15	14	0.07	0.06	1	0.01	291	280	0.42	0.40	11	0.02
	GRAYSON	6	108	1,810	1,686	8.66	7.70	133	1.03	45,402	43,815	43.67	41.49	1,587	2.18
	GRIMES	4	15	223	208	0.95	0.85	15	0.11	3,296	3,167	5.79	5.51	128	0.28
	HALL	8	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	HAMILTON	5	3	49	42	0.24	0.19	8	0.05	1,243	1,206	1.32	1.26	37	0.06
	HARDEMAN	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	HASKELL	6	1	16	14	0.07	0.06	2	0.01	527	490	0.45	0.43	37	0.02
	HIDALGO	2	2,793	48,256	41,375	211.09	173.64	7,363	40.07	542,599	534,257	1,047.70	996.02	8,342	51.68
	HILL	5	14	230	197	1.12	0.90	35	0.24	5,801	5,628	6.16	5.87	173	0.28
	HOPKINS	6	8	134	125	0.64	0.57	10	0.08	3,356	3,239	3.23	3.07	117	0.16
	HOUSTON	5	3	42	40	0.17	0.16	2	0.02	988	953	1.22	1.16	35	0.06
	HOWARD	6	2	29	26	0.11	0.09	4	0.02	1,007	942	0.93	0.89	65	0.04
	HUDSPETH	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	IRION	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	JACK	6	10	158	137	0.68	0.55	22	0.14	5,270	4,896	4.50	4.30	374	0.20
	JACKSON	3	7	99	94	0.41	0.37	6	0.04	1,643	1,583	2.81	2.68	60	0.13
	JEFF DAVIS	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	JIM HOGG	2	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	JIM WELLS	3	11	172	160	0.69	0.62	13	0.08	2,179	2,094	4.31	4.10	85	0.20
	JONES	6	1	16	14	0.07	0.06	2	0.01	527	490	0.45	0.43	37	0.02
	KARNES	3	51	782	677	3.67	2.99	113	0.73	12,719	12,576	21.81	20.78	143	1.03
	KENDALL	5	148	2,203	1,916	10.17	8.28	307	2.02	39,338	37,482	62.01	59.02	1,857	2.99
	KENEDY	2	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	KENT	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	KERR	5	46	747	692	3.49	3.10	59	0.42	11,890	11,447	19.11	18.18	444	0.93
	KIMBLE	5	1	15	13	0.06	0.05	2	0.01	508	493	0.44	0.42	15	0.02
	KING	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	KINNEY	4	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	KLEBERG	2	30	493	426	2.19	1.81	72	0.40	5,577	5,489	11.35	10.79	89	0.56
	KNOX	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	LA SALLE	3	6	105	88	0.47	0.38	18	0.09	1,207	1,176	2.48	2.35	31	0.12
	LAMAR	6	27	418	372	1.97	1.63	49	0.36	9,210	8,548	10.05	9.55	661	0.50
	LAMPASAS	5	15	246	211	1.20	0.96	38	0.26	6,216	6,030	6.60	6.29	186	0.30
	LAVACA	4	6	88	78	0.40	0.34	11	0.07	1,392	1,336	2.35	2.24	56	0.11
	LEE	4	7	114	105	0.53	0.47	9	0.06	1,813	1,745	2.91	2.77	68	0.14
	LEON	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	LIMESTONE	5	2	33	28	0.16	0.13	5	0.03	829	804	0.88	0.84	25	0.04
	LIVE OAK	3	8	125	116	0.50	0.45	9	0.06	1,585	1,523	3.13	2.98	62	0.15
	LLANO	5	136	2,209	2,047	10.33	9.17	173	1.24	35,154	33,842	56.50	53.75	1,312	2.75
	LOVING	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	MADISON	4	12	178	167	0.76	0.68	12	0.08	2,637	2,534	4.63	4.41	103	0.22
	MARTIN	6	1	15	13	0.06	0.05	2	0.01	504	471	0.47	0.45	33	0.02
	MASON	5	3	49	45	0.23	0.20	4	0.03	775	747	1.25	1.19	29	0.06
	MATAGORDA	3	79	1,120	1,055	4.67	4.22	70	0.49	18,539	17,863	31.68	30.22	676	1.46
	MAVERICK	3	101	1,771	1,489	7.89	6.42	302	1.58	20,316	19,791	41.67	39.63	525	2.04
	MCCULLOCH	5	1	15	13	0.06	0.05	2	0.01	508	493	0.44	0.42	15	0.02
	MCLENNAN	5	424	6,958	5,965	34.05	27.17	1,062	7.36	175,695	170,444	186.45	177.90	5,251	8.56
	MCMULLEN	3	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
ERCOT	MEDINA	4	14	214	200	0.96	0.86	15	0.11	4,079	3,926	5.94	5.66	153	0.28
	MENARD	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	MIDLAND	6	330	4,858	4,261	18.96	15.59	638	3.60	166,177	155,417	153.98	147.32	10,760	6.66
	MILAM	4	2	33	28	0.16	0.13	5	0.03	476	476	0.83	0.79	1	0.04
	MILLS	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	MITCHELL	6	1	16	14	0.07	0.06	2	0.01	527	490	0.45	0.43	37	0.02
	MONTAGUE	6	1	17	16	0.08	0.07	1	0.01	420	406	0.40	0.38	15	0.02
	MOTLEY	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	NACOGDOCHES	5	40	565	536	2.32	2.10	31	0.24	13,173	12,710	16.21	15.47	464	0.74
	NAVARRO	5	21	345	295	1.69	1.35	53	0.36	8,702	8,442	9.23	8.81	260	0.42
	NOLAN	6	1	16	14	0.07	0.06	2	0.01	527	490	0.45	0.43	37	0.02
	PALO PINTO	6	6	95	82	0.41	0.33	13	0.08	3,162	2,938	2.70	2.58	225	0.12
	PECOS	5	6	92	80	0.38	0.31	13	0.08	3,046	2,955	2.67	2.55	90	0.12
	PRESIDIO	5	5	76	66	0.32	0.26	11	0.07	2,538	2,463	2.22	2.12	75	0.10
	RAINS	6	3	50	47	0.24	0.21	4	0.03	1,259	1,215	1.21	1.15	44	0.06
	REAGAN	5	3	44	39	0.17	0.14	6	0.03	1,512	1,489	1.40	1.34	23	0.06
	REAL	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	RED RIVER	6	7	108	97	0.51	0.42	13	0.09	2,388	2,216	2.61	2.48	171	0.13
	REEVES	6	1	15	13	0.06	0.05	2	0.01	504	471	0.47	0.45	33	0.02
	REFUGIO	3	8	113	107	0.47	0.43	7	0.05	1,877	1,809	3.21	3.06	68	0.15
	ROBERTSON	4	8	119	111	0.51	0.45	8	0.06	1,758	1,689	3.09	2.94	68	0.15
	RUNNELS	5	2	31	27	0.13	0.10	4	0.03	1,015	985	0.89	0.85	30	0.04
	SAN SABA	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	SCHLEICHER	5	2	31	27	0.13	0.10	4	0.03	1,015	985	0.89	0.85	30	0.04
	SCURRY	7	3	45	40	0.15	0.13	5	0.03	1,878	1,688	1.35	1.29	190	0.06
	SHACKELFORD	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	SOMERVELL	5	29	485	452	2.33	2.07	36	0.28	12,156	11,727	11.73	11.14	428	0.59
	STARR	2	2	35	30	0.15	0.12	5	0.03	389	383	0.75	0.71	6	0.04
	STEPHENS	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	STERLING	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	STONEWALL	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	SUTTON	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	TAYLOR	6	201	3,172	2,757	13.67	11.12	443	2.73	105,936	98,414	90.53	86.48	7,522	4.06
	TERRELL	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	THROCKMORTON	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	TITUS	6	10	155	138	0.73	0.60	18	0.13	3,411	3,166	3.72	3.54	245	0.19
	TOM GREEN	5	181	2,767	2,403	11.51	9.30	390	2.36	91,876	89,149	80.50	76.85	2,727	3.65
	UPTON	5	1	15	13	0.06	0.05	2	0.01	504	496	0.47	0.45	8	0.02
	UVALDE	4	19	290	271	1.31	1.17	20	0.15	5,536	5,328	8.07	7.68	208	0.38
	VAL VERDE	4	44	673	628	3.03	2.71	47	0.34	12,819	12,338	18.68	17.79	481	0.89
	VAN ZANDT	6	13	218	203	1.05	0.93	16	0.12	5,454	5,263	5.26	4.99	191	0.26
	WARD	6	7	103	90	0.40	0.33	14	0.08	3,525	3,297	3.27	3.13	228	0.14
	WASHINGTON	4	82	1,217	1,138	5.18	4.64	84	0.58	18,017	17,315	31.64	30.12	702	1.52
	WEBB	3	668	11,713	9,850	52.20	42.45	1,994	10.43	134,368	130,893	275.57	262.09	3,475	13.48
	WHARTON	3	70	993	935	4.14	3.73	62	0.43	16,427	15,828	28.07	26.78	599	1.30
	WICHITA	7	161	2,689	2,320	12.10	9.72	395	2.55	96,211	86,649	71.37	68.12	9,562	3.25
	WILBARGER	7	1	17	14	0.08	0.06	2	0.02	598	538	0.44	0.42	59	0.02
	WILLACY	2	25	432	370	1.89	1.55	66	0.36	4,857	4,782	9.38	8.92	75	0.46
	WINKLER	6	1	15	13	0.06	0.05	2	0.01	504	471	0.47	0.45	33	0.02
	WISE	6	32	537	500	2.57	2.29	39	0.31	13,425	12,955	12.94	12.29	470	0.65
	YOUNG	6	5	79	69	0.34	0.28	11	0.07	2,635	2,448	2.25	2.15	187	0.10
	ZAPATA	2	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	ZAVALA	3	8	140	118	0.63	0.51	24	0.12	1,609	1,568	3.30	3.14	42	0.16
	TOTAL		66,095					85,312	587					762,901	1,283

Table 6: 2007 Allocation of PCA for each of 41 Non-attainment and Affected Counties, and ERCOT Counties (1)

County	Elec. Utilities 1	PCA	1998 Annual net Generation (MWh)	Percentage	Elec. Utilities 2	PCA	1998 Annual net Generation (MWh)	Percentage
ANDERSON	ONCOR	TXU Electric/PCA	97581030	100%	Trinity Valley EC			0%
ANDREWS	ONCOR	TXU Electric/PCA	97581030	100%	Cap Rock EC			0%
ANGELINA	ONCOR	TXU Electric/PCA	97581030	100%	Sam Houston EC			0%
ARANSAS	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	San Patricio EC			0%
ARCHER	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
ATASCOSA	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	54%	CPSB	San Antonio Public Service Bd/PCA	14,641,059	46%
AUSTIN	RELIANT(CENTER POINT)	Reliant Energy HL&P/PCA	74,386,176	100%	Bellville			0%
BANDERA*	Bandera EC							
BASTROP	ONCOR	TXU Electric/PCA	97581030	100%	Smithville			0%
BAYLOR	ONCOR	TXU Electric/PCA	97581030	100%	Seymour			0%
BEE	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	San Patricio EC			0%
BELL	ONCOR	TXU Electric/PCA	97581030	100%	Bartlett EC			0%
BEXAR	CPSB	San Antonio Public Service Bd/PCA	14,641,059	100%	Bandera EC			0%
BLANCO*	Pedernales EC				Central Texas EC			
BORDEN*	Lyntegar EC				Big Country EC			
BOSQUE	T-NMP	Texas-New Mexico Power Co/PCA	2067714	100%	United Coop Services			0%
BRAZORIA	RELIANT(CENTER POINT)	Reliant Energy HL&P/PCA	74,386,176	97%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	3%
BRAZOS*	BRYAN				College Station			
BREWSTER	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Rio Grande EC			0%
BRISCOE	XCEL(SPS)				WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%
BROOKS	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Medina EC			0%
BROWN	ONCOR	TXU Electric/PCA	97581030	85%	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	15%
BURLESON	ENTERGY	Entergy Electric System/PCA	32,288,113	100%	BRYAN			0%
BURNET	ONCOR	TXU Electric/PCA	97581030	100%	Pedernales EC			0%
CALDWELL	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Luling			0%
CALHOUN	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Victoria EC			0%
CALLAHAN	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Taylor EC			0%
CAMERON	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Magic Valley EC			0%
CHAMBERS	RELIANT(CENTER POINT)	Reliant Energy HL&P/PCA	74,386,176	70%	ENTERGY	Entergy Electric System/PCA	32,288,113	30%
CHEROKEE	ONCOR	TXU Electric/PCA	97581030	100%	Cherokee County EC			0%
CHILDRESS	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Greenbelt EC			0%
CLAY	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
COKE	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Concho Valley EC			0%
COLEMAN	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Coleman			0%
COLLIN	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
COLORADO	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Weimar			0%
COMAL	CPSB	San Antonio Public Service Bd/PCA	14,641,059	100%	New Braunfels			0%
COMANCHE	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
CONCHO	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Concho Valley EC			0%
COOKE	ONCOR	TXU Electric/PCA	97581030	100%	Cooke County EC			0%
CORYELL	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
COTTLE	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	South Plains EC			0%
CRANE	ONCOR	TXU Electric/PCA	97581030	100%				0%
CROCKETT	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Rio Grande EC			0%
CROSBY*	XCEL(SPS)				Crosbyton			
CULBERSON	EPEC	El Paso Electric Co/PCA	3066882	100%	Rio Grande EC			0%
DALLAS	ONCOR	TXU Electric/PCA	97581030	100%	Garland			0%
DAWSON	ONCOR	TXU Electric/PCA	97581030	100%	Lyntegar EC			0%
DELTA	ONCOR	TXU Electric/PCA	97581030	100%	Lamar County EC			0%
DENTON	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
DEWITT	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Yoakum			0%
DICKENS	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	South Plains EC			0%
DIMMIT	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Medina EC			0%
DUVAL	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Medina EC			0%
EASTLAND	ONCOR	TXU Electric/PCA	97581030	85%	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	15%
ECTOR	ONCOR	TXU Electric/PCA	97581030	100%	Goldsmith			0%
EDWARDS	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Rio Grande EC			0%
ELLIS	ONCOR	TXU Electric/PCA	97581030	100%	Navarro County EC			0%
ERATH	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
FALLS	ONCOR	TXU Electric/PCA	97581030	100%	Belfalls EC			0%
FANNIN	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
FAYETTE*	La Grange				Schulenburg			
FISHER	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Big Country EC			0%
FOARD*	XCEL(SPS)				Floydada			
FORT BEND	RELIANT(CENTER POINT)	Reliant Energy HL&P/PCA	74,386,176	100%				0%
FRANKLIN	SWEPCO(AEP)	Southwestern Public Service Co/PCA			FEC Electric			
FREESTONE	ONCOR	TXU Electric/PCA	97581030	100%	Navasota Valley EC			0%
FRIO	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Medina EC			0%
GALVESTON	RELIANT(CENTER POINT)	Reliant Energy HL&P/PCA	74,386,176	97%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	3%
GILLESPIE*	Fredericksburg				Pedernales EC			
GLASSCOCK	ONCOR	TXU Electric/PCA	97581030	100%	Cap Rock EC			0%
GOLIAD	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Karnes EC			0%
GONZALES	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Gonzales			0%
GRAYSON	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
GRIMES	ENTERGY	Entergy Electric System/PCA	32,288,113	100%	Mid-South EC			0%
GUADALUPE	CPSB	San Antonio Public Service Bd/PCA	14,641,059	100%	Seguin			0%
HALL	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Lighthouse EC			0%
HAMILTON	T-NMP	Texas-New Mexico Power Co/PCA	2067714	100%	United Coop Services			0%
HARDEMAN	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	South Plains EC			0%
HARRIS	RELIANT(CENTER POINT)	Reliant Energy HL&P/PCA	74,386,176	70%	ENTERGY	Entergy Electric System/PCA	32,288,113	30%
HASKELL	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Big Country EC			0%
HAYS	San Marcos	Lower Colorado River Authority/PCA		100%	Pedernales EC			0%
HENDERSON	ONCOR	TXU Electric/PCA	97581030	100%	Trinity Valley EC			0%
HIDALGO	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Magic Valley EC			0%
HILL	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
HOOD	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
HOPKINS	ONCOR	TXU Electric/PCA	97581030	100%	SWEPCO(AEP)			0%
HOUSTON	ONCOR	TXU Electric/PCA	97581030	100%	Houston County EC			0%
HOWARD	ONCOR	TXU Electric/PCA	97581030	100%	Cap Rock EC			0%
HUDSPETH	EPEC	El Paso Electric Co/PCA	3066882	100%	Rio Grande EC			0%
HUNT	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
IRION	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Cap Rock EC			0%
JACK	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
JACKSON	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Jackson EC			0%
JEFF DAVIS	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Rio Grande EC			0%
JIM HOGG	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Medina EC			0%
JIM WELLS	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Nueces EC			0%
JOHNSON	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
JONES	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Taylor EC			0%
KARNES	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Floresville			0%

Table 7: 2006 Allocation of PCA for each of 41 Non-attainment and Affected Counties, and ERCOT Counties (2)

County	Elec. Utilities 1	PCA	1998 Annual net Generation (MWh)	Percentage	Elec. Utilities 2	PCA	1998 Annual net Generation (MWh)	Percentage
KAUFMAN	ONCOR	TXU Electric/PCA	97581030	100%	Trinity Valley EC			0%
KENDALL*	Boerne				Central Texas EC			
KENEDY*	Nueces EC				Magic Valley EC			
KENT	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	South Plains EC			0%
KERR*	Kerrville				Bandera EC			
KIMBLE	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Central Texas EC			0%
KING	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	South Plains EC			0%
KINNEY	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Rio Grande EC			0%
KLEBERG	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Nueces EC			0%
KNOX	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Tri-County EC			0%
LA SALLE	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Medina EC			0%
LAMAR	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
LAMPASAS	ONCOR	TXU Electric/PCA	97581030	100%	Lampasas			0%
LAVACA*	Schulenburg				Yoakum			
LEE*	Giddings				Lexington			
LEON	ONCOR	TXU Electric/PCA	97581030	75%	ENTERGY	Entergy Electric System/PCA	32,288,113	25%
LIMESTONE	ONCOR	TXU Electric/PCA	97581030	75%	ENTERGY	Entergy Electric System/PCA	32,288,113	25%
LIVE OAK	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	San Patricio EC			0%
LLANO*	Llano				Pedernales EC			
LOVING	ONCOR	TXU Electric/PCA	97581030	100%				0%
MADISON	ENTERGY	Entergy Electric System/PCA	32,288,113	100%	Houston County EC			0%
MARTIN	ONCOR	TXU Electric/PCA	97581030	100%	Cap Rock EC			0%
MASON*	Mason				Cap Rock EC			
MATAGORDA	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	19%	RELIANT(CENTER POINT)	Reliant Energy HL&P/PCA	74,386,176	81%
MAVERICK	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Rio Grande EC			0%
McCULLOCH	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Brady			0%
McLENNAN	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
McMULLEN	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Karnes EC			0%
MEDINA	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	54%	CPSB	San Antonio Public Service Bd/PCA	14,641,059	46%
MENARD	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Cap Rock EC			0%
MIDLAND	ONCOR	TXU Electric/PCA	97581030	100%	Cap Rock EC			0%
MILAM	ONCOR	TXU Electric/PCA	97581030	75%	ENTERGY	Entergy Electric System/PCA	32,288,113	25%
MILLS*	Goldwaithe				Cap Rock EC			
MITCHELL	ONCOR	TXU Electric/PCA	97581030	100%	Cap Rock EC			0%
MONTAGUE	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
MONTGOMERY	ENTERGY	Entergy Electric System/PCA	32,288,113	30%	RELIANT(CENTER POINT)	Reliant Energy HL&P/PCA	74,386,176	70%
MOTLEY	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Lighthouse EC			0%
NACOGDOCHES	ONCOR	TXU Electric/PCA	97581030	100%	Cherokee County EC			0%
NAVARRO	ONCOR	TXU Electric/PCA	97581030	100%	Navarro County EC			0%
NOLAN	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	15%	ONCOR	TXU Electric/PCA	97,581,030	85%
NUECES	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Robstown			0%
PALO PINTO	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
PARKER	ONCOR	TXU Electric/PCA	97581030	100%	Weatherford			0%
PECOS	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	15%	ONCOR	TXU Electric/PCA	97,581,030	85%
PRESIDIO	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Rio Grande EC			0%
RAINS	T-NMP	Texas-New Mexico Power Co/PCA	2067714	100%	FEC Electric			0%
REAGAN	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Cap Rock EC			0%
REAL	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Bandera EC			0%
RED RIVER	ONCOR	TXU Electric/PCA	97581030	100%	SWEPCO(AEP)			0%
REEVES	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	15%	ONCOR	TXU Electric/PCA	97,581,030	85%
REFUGIO	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	San Patricio EC			0%
ROBERTSON	ENTERGY	Entergy Electric System/PCA	32,288,113	100%	Hearne			0%
ROCKWALL	ONCOR	TXU Electric/PCA	97581030	100%	FEC Electric			0%
RUNNELS	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Coleman County EC			0%
RUSK	SWEPCO(AEP)	Southwestern Public Service Co/PCA		0%	ONCOR	TXU Electric/PCA	97,581,030	100%
SAN PATRICIO	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	San Patricio EC			0%
SAN SABA*	San Saba				Central Texas EC			
SCHLEICHER	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Pedernales EC			0%
SCURRY	ONCOR	TXU Electric/PCA	97581030	100%	Cap Rock EC			0%
SHACKELFORD	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Fort Belknap EC			0%
SMITH	ONCOR	TXU Electric/PCA	97581030	100%	SWEPCO(AEP)			0%
SOMERVELL	T-NMP	Texas-New Mexico Power Co/PCA	2067714	100%	United Coop Services			0%
STARR	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Medina EC			0%
STEPHENS	ONCOR	TXU Electric/PCA	97581030	100%	Comanche EC			0%
STERLING	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Cap Rock EC			0%
STONEWALL	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Big Country EC			0%
SUTTON	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Pedernales EC			0%
TARRANT	ONCOR	TXU Electric/PCA	97581030	100%	Tri-County EC			0%
TAYLOR	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Taylor EC			0%
TERRELL	T-NMP	Texas-New Mexico Power Co/PCA	2067714	100%	Rio Grande EC			0%
THROCKMORTON	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Fort Belknap EC			0%
TITUS	SWEPCO(AEP)	Southwestern Public Service Co/PCA		0%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	100%
TOM GREEN	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Concho Valley EC			0%
TRAVIS	ONCOR	TXU Electric/PCA	97581030	97%	Austin Energy	Austin Energy/PCA	3,359,240	3%
UPTON	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	15%	ONCOR	TXU Electric/PCA	97,581,030	85%
UVALDE	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Bandera EC			0%
VAL VERDE	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Rio Grande EC			0%
VAN ZANDT	ONCOR	TXU Electric/PCA	97581030	100%	SWEPCO(AEP)			0%
VICTORIA	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Victoria EC			0%
WALLER	RELIANT(CENTER POINT)	Reliant Energy HL&P/PCA	74,386,176	100%	Hempstead			0%
WARD	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
WASHINGTON	ENTERGY	Entergy Electric System/PCA	32,288,113	100%	Bluebonnet EC			0%
WEBB	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Rio Grande EC			0%
WHARTON	RELIANT(CENTER POINT)	Reliant Energy HL&P/PCA	74,386,176	81%	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17162569	19%
WICHITA	ONCOR	TXU Electric/PCA	97581030	100%	Electra			0%
WILBARGER	WTU(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Vernon			0%
WILLACY	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Magic Valley EC			0%
WILLIAMSON	ONCOR	TXU Electric/PCA	97581030	97%	Austin Energy	Austin Energy/PCA	3,359,240	3%
WILSON	Floresville	San Antonio Public Service Bd/PCA		100%	Guadalupe Valley EC			
WINKLER	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
WISE	ONCOR	TXU Electric/PCA	97581030	100%	Bridgeport			0%
YOUNG	ONCOR	TXU Electric/PCA	97581030	98%	T-NMP	Texas-New Mexico Power Co/PCA	2,067,714	2%
ZAPATA	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Medina EC			0%
ZAVALA	CPL(AEP)	American Electric Power - West (ERCOT)/PCA	17,162,569	100%	Medina EC			0%

Table 8: 2009 Totalized Annual Electricity Savings from IECC/IRC by PCA for Single-family Residences Using 1999 Base Year

PCA	Total Electricity Savings by PCA (MWh) 2009-TRY1999
American Electric Power - West (ERCOT)/PCA	15,215.78
Austin Energy/PCA	254.46
Brownsville Public Utils Board/PCA	0.00
Lower Colorado River Authority/PCA	1,337.10
Reliant Energy HL&P/PCA	18,565.20
San Antonio Public Service Bd /PCA	5,776.37
South Texas Electric Coop Inc/PCA	0.00
Texas Municipal Power Pool/PCA	0.00
Texas-New Mexico Power Co/PCA	391.58
TXU Electric/PCA	34,647.01
El Paso Electric Co/PCA	30.00
Entergy Electric System/PCA	4,792.06
Total	81,009.56

Table 9: 2009 Annual NOx Reductions from IECC/IRC by PCA for Single-family Residences by County Using 2007 eGRID

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs/year)	Lower Colorado River Auhotrity /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/PCA	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.00883113	134.372555	0.010890729	2.77126607	0.006522185	0	0.003944232	5.273842485	0.0654443	1214.986342	0.014877	85.9375004	0.006262	0	0.0048171	0	0.121275	47.48901088	0.00816387	282.8537285	1773.684245	0.886842122
	Chambers	0.02176222	331.129159	0.026955801	6.85920075	0.016072371	0	0.009076193	12.13580095	0.1649402	3062.148215	0.037472	216.453679	0.015056	0	0.0095532	0	0.011519	4.510464278	0.01581859	548.0670023	4181.303521	2.09065176
	Fort Bend	0.07043123	1071.66607	0.087239726	22.1991103	0.052016606	0	0.029374182	39.27629379	0.5338124	9910.33335	0.121275	700.530464	0.048726	0	0.030918	0	0.037279	14.59766198	0.05119528	1773.763485	13532.36644	6.766183219
	Galveston	0.03385674	515.156654	0.041710519	10.6137014	0.025004711	0	0.015351589	20.5266485	0.2495874	4633.639524	0.056747	327.791727	0.024143	0	0.0192972	0	0.567751	222.3207873	0.03283689	1137.700096	6867.749138	3.433874569
	Harris	0.06826733	1038.74063	0.084559408	21.5170736	0.050418468	0	0.028471701	38.06958451	0.5174117	9605.852198	0.117549	679.007644	0.047229	0	0.0299681	0	0.036133	14.1491692	0.04962237	1719.267079	13116.60338	6.558301688
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.00203914	31.0270293	0.003716345	0.94566487	0.001505992	0	0.005950953	7.957034068	0.0024815	46.06913805	0.000717	4.14194736	0.019166	0	0.0766809	0	0.000864	0.338486889	0.0040002	138.5949645	229.074265	0.114537132
	Dallas	0.00453947	69.0715887	0.004683963	1.19188593	0.003352602	0	0.00774211	10.351995	0.0020856	38.71978837	0.000681	3.93405359	0.007503	0	0.026717	0	0.007525	2.946623432	0.04037045	1398.715711	1524.931646	0.762465823
	Denton	0.00047388	7.2104577	0.000872802	0.22209397	0.000349982	0	0.001396994	1.867924038	0.0005854	10.86887287	0.000169	0.97603551	0.004544	0	0.0181872	0	0.000187	0.073071231	0.00084941	29.42936089	50.6478162	0.025323908
	Tarrant	0.01216249	185.061793	0.012266309	3.12129768	0.008982543	0	0.020308652	27.15475074	0.0053165	98.70196767	0.001753	10.1231162	0.017326	0	0.0602168	0	0.020603	8.067924506	0.11064724	3833.596447	4165.827296	2.082913648
	Ellis	0.00327981	49.9049171	0.003307809	0.8417086	0.002422289	0	0.005476558	7.322719435	0.0014337	26.61658816	0.000473	2.72986265	0.004672	0	0.0162384	0	0.005556	2.175646838	0.02983782	1033.791526	1123.382969	0.561691484
	Johnson	0.00028606	4.35260255	0.000526868	0.13406733	0.000211267	0	0.000843297	1.127574875	0.0003534	6.561009825	0.000102	0.58918516	0.002743	0	0.0109787	0	0.000113	0.044109547	0.00051274	17.76507355	30.57362283	0.015286811
	Kaufman	0.00632545	96.2466862	0.006379446	1.62332026	0.004671629	0	0.010562096	14.12260595	0.002765	51.33278555	0.000911	5.26481655	0.009011	0	0.0313175	0	0.010715	4.195955241	0.05754527	1993.771643	2166.557813	1.083278907
	Parker	0.00021749	3.30927184	0.000400576	0.10193102	0.000160626	0	0.000641157	0.857292098	0.0002687	4.988317854	7.75E-05	0.44795587	0.002085	0	0.0083471	0	8.56E-05	0.033536368	0.00038984	13.50673691	23.24504195	0.011622521
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.00081989	12.4753399	0.000826893	0.21041215	0.000605529	0	0.001369042	1.830549356	0.0003584	6.653672688	0.000118	0.68241701	0.001168	0	0.0040593	0	0.001389	0.543872936	0.00745892	258.4294576	280.8257217	0.140412861
	Hood	0.01252711	190.609733	0.012634039	3.21487061	0.009251829	0	0.020917482	27.96881907	0.0054759	101.6609396	0.001805	10.4265956	0.017846	0	0.062022	0	0.021221	8.309791644	0.11396431	3948.523278	4290.714028	2.145357014
	Hunt	0.00618756	94.1485192	0.006240374	1.58793206	0.004569788	0	0.010331844	13.81473472	0.0027047	50.21373657	0.000892	5.15004413	0.008815	0	0.0306347	0	0.010482	4.104483886	0.05629078	1950.307644	2119.327095	1.059663548
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.03341375	508.416244	0.051775843	13.1749342	0.024677545	0	0.090663423	121.2262953	0.0011418	21.19851092	1.143572	6605.68877	0.046874	0	0.0046695	0	0.00052	0.203458747	0.00250387	86.75145355	7356.65967	3.678329835
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.00200047	30.4386659	0.076378745	19.4354137	0.001477434	0	0.133848731	178.9694802	0.0012371	22.96761685	0.003555	20.5338036	0.001062	0	0.0018557	0	0.000402	0.157305404	0.00183516	63.58298233	336.085268	0.168042634
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.00450233	68.5065152	0.171901148	43.7421426	0.003325174	0	0.301245466	402.7960831	0.0027843	51.69186444	0.008001	46.2142241	0.00239	0	0.0041765	0	0.000904	0.354038022	0.0041303	143.1024788	756.4073463	0.378203673
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.0024586	37.4095007	0.093870431	23.8863663	0.001815785	0	0.164501762	219.9557272	0.0015205	28.22748808	0.004369	25.2363012	0.001305	0	0.0022807	0	0.000494	0.193330307	0.00225544	78.14427971	413.0529936	0.206526497
	Travis	0.00051001	7.76015387	0.299602906	76.2372628	0.000376663	0	0.033939476	45.38056046	0.0003347	6.213935426	0.000906	5.23408641	0.000271	0	0.0004717	0	0.000103	0.040460874	0.00046734	16.19178925	157.0582491	0.078529125
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0.00068596	10.4374893	0.00069182	0.17604126	0.000506616	0	0.001145408	1.531528553	0.0002999	5.566793199	9.88E-05	0.57094398	0.000977	0	0.0033962	0	0.001162	0.455031124	0.00624051	216.2149259	234.9527533	0.117476377
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22756873	3462.63545	0.004556851	1.15954106	0.168069652	0	0.007612767	10.17905038	0.0016809	31.20601873	0.001627	9.39696868	0.046792	0	0.0072464	0	0.001609	0.630221187	0.00828339	286.9948978	3802.202151	1.901101075
	San Patricio	0.05031335	765.556823	0.001007478	0.25636385	0.037158653	0	0.001683113	2.250494334	0.0003716	6.899363469	0.00036	2.07758327	0.010345	0	0.0016021	0	0.000356	0.139336103	0.00183138	63.45192993	840.6318937	0.420315947
Victoria Area	Victoria	0.02183674	332.262939	0.002215582	0.56377931	0.016127403	0	0.003612695	4.83054408	0.0011996	22.27120563	0.000555	3.20812884	0.525456	0	0.0324127	0	0.000477	0.186727655	0.00225485	78.12379199	441.4471169	0.220723558
Other ERCOT counties	Andrews	2.4742E-05	0.37647006	2.49533E-05	0.00634964	1.82731E-05	0	4.13138E-05	0.055240741	1.082E-05	0.2007888	3.57E-06	0.02059339	3.52E-05	0	0.0001225	0	4.19E-05	0.016412529	0.00022509	7.798661446	8.4745166	0.004237258
	Angelina	0.00031082	4.72936714	0.000313473	0.07976667	0.000229554	0	0.000519	0.69395624	0.0001359	2.522389067	4.48E-05	0.25870242	0.000443	0	0.0015389	0	0.000527	0.206180738	0.00282766	97.96989862	106.4602609	0.05323013
	Bosque	0.00059539	9.05934948	0.001096604	0.27904288	0.000439723	0	0.001755208	2.34689355	0.0007356	13.65584848	0.000212	1.22630867	0.005709	0	0.0228507	0	0.000234	0.091808016	0.00106721	36.97558137	63.63483244	0.031817416
	Brazos	0.00193973	29.5144296	0.003572622	0.90909303	0.001432574	0	0.005718288	7.645938001	0.0023964	44.48935097	0.000692	3.99518761	0.018599	0	0.0744451	0	0.000764	0.299101081	0.00347685	120.4626442	207.3157445	0.103657872
	Calhoun	0.08269981	1258.34199	0.001655986	0.42138401	0.061077496	0	0.002766524	3.699126495	0.0006108	11.34044989	0.000591	3.41491343	0.017004	0	0.0026334	0	0.000585	0.229026068	0.00301023	104.2956259	1381.742519	0.69087126
	Cameron	0.04837175	736.013801	0.000968599	0.24647071	0.297964476	0	0.001618161	2.163647217	0.0003573	6.633115377	0.000346	1.99740883	0.009946	0	0.0015403	0	0.000342	0.133959089	0.00176071	61.00330471	808.191707	0.404095854
	Cherokee	0.0035039	53.3145505	0.003533808	0.89921631	0.002587786	0	0.00585073	7.823026626	0.0015316	28.43510252	0.000505	2.91637394	0.004992	0	0.0173479	0	0.005936	2.324292675	0.03187642	1104.422845	1200.135408	0.600067704
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.00129879	19.7620538	2.6007E-05	0.00661777	0.000959212	0	4.34478E-05	0.058094173	9.593E-06	0.178099898	9.28E-06	0.05363065	0.000267	0	4.136E-05	0	9.19E-06	0.003596817	4.7275E-05	1.637945635	21.70003879	0.010850019
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.00353575	53.7991538	0.003565928	0.90738975	0.002611307	0	0.005903911	7.894134127	0.0015456	28.69356375	0.000509	2.94288236	0.005037	0	0.0175056	0	0.00599	2.345419363	0.03216616	1114.461511	1211.044054	0.605522027
	Fannin	0.00705631	107.367323	0.007116546	1.81088367	0.005211403	0	0.011782473	15.75437515	0.0030845	57.26393301	0.001017	5.8731296	0.010052	0	0.034936	0	0.011954	4.680768776	0.06419422	2224.138133	2416.888547	1.208444273
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.00367718	55.95112	0.003708565	0.94368534	0.00271576	0	0.006140067	8.209899492	0.0016074	29.8413063	0.00053	3.06059766	0.005238	0	0.0182058	0	0.006229	2.439236138	0.03345281	1159.039972	1259.485817	0.629742908
	Frio	0.00858833	130.6782	0.000871383	0.22173302	0.006342868	0	0.001420864	1.899841154	0.0004718	8.75921062	0.000218	1.26174921	0.206661	0	0.0127478	0	0.000188	0.073439529	0.00088683	30.72589603	173.6200698	0.086810035
	Grimes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.18852746	2868.59206	0.003775086	0.96061232	0.139235931	0	0.006306735	8.432751159	0.0013925	25.85237138	0.001348	7.78484196	0.038764	0	0.0060032	0	0.001333	0.522101595	0.00686231	237.7585794	3149.903321	1.574951661
	Howard	0.00055511	8.44647733	0.000559851	0.14246036	0.000409976	0	0.000926915	1.239380551	0.0002427	4.504894935	8E-05	0.46203309	0.000791	0	0.0027484	0	0.00094	0.368231284	0.00505009	174.970668	190.1341456	0.095067073
	Jack	0.00212145	32.2794923	0.002139557	0.54443385	0.001566784	0	0.003542346	4.736480476	0.0009273	17.21613825	0.000306	1.76572942	0.003022	0	0.0105033	0	0.003594	1.407251618	0.0192997	668.6769067	726.6264326	0.363313216
	Jones	0.04071872	619.567069	0.000815354	0.20747591	0.030072592	0	0.001362147	1.821330744	0.0003008	5.58367227	0.000291	1.68139338	0.008372	0	0.0012966	0	0.000288	0.11276506	0.00148214	51.35180704	680.3255133	0.340162757
	Lamar	0.00095084	14.4677383	0.000958954	0.24401643	0.000702236	0	0.001587687	2.1229008	0.0004156	7.716310422	0.000137	0.79140375	0.001355	0	0.0047076	0	0.001611	0.630733221	0.00865017	299.7024367	325.6755396	0.16283777
	Limestone	0.00071976	10.95166	0.000891528	0.22685901	0.000531572	0	0.000300183	0.401375603	0.0054552	101.2765115	0.001239	7.1589198	0.000498	0	0.000316	0	0.000381	0.149177654	0.00052318	18.12659289	138.2910965	0.069145548
	Llano	0.00123817	18.839781	0.047274044	12.0294016	0.000914447	0	0.082844655	110.7717997	0.0007657	14.21563192	0.0022	12.7092417	0.000657	0	0.0011486	0	0.000249	0.097362985	0.00113586	39.35420374	208.0174227	0.104008711
	McLennan	0.02453432	373.308744	0.024743738	6.29631702	0.018119687	0	0.040966843	54.77687072	0.0107245	199.102727	0.003535	20.4204646	0.034951	0	0.1214699	0	0.041562	16.27470868	0.22319886	7733.174169	8403.354001	4.201677
	Milam	0.0022454	34.1655845	0.002264571	0.57624514	0.001658332	0	0.003749326	5.013233239	0.0009815	18.22207797	0.000324	1.86890107	0.003199	0	0.011117	0	0.003804	1.489477392	0.02042738	707.7477278	769.0832471	0.384541624
	Mitchell	0.01494317	227.37195	0.015070721	3.83491118	0.011036196	0	0.024951762	33.36306501	0.006532	121.2679209	0.002153	12.4375358	0.021288	0	0.073984	0	0.025314	9.91247139	0.1359442	4710.060818	5118.248672	2.559124336
	Nolan	0.00056465	8.59164583	0.000569473	0.14490881	0.000417022	0	0.000942846	1.260681623	0.0002468	4.582319978	8.14E-05	0.46997399	0.000804	0	0.0027956	0	0.000957	0.374560027	0.00513689	177.9778661	193.4019564	0.096700978
	Palo Pinto	0.003207	48.7969773	0.005906709	1.50302726	0.002368511	0	0.009454195	12.641229	0.003962	73.55540595	0.001144	6.60534803	0.03075	0	0.1230821	0	0.001263	0.494511629	0.00574838	199.1640359	342.7605351	0.171380268
	Pecos	4.0968E-05	0.62335514	4.13174E-05	0.01051366	3.02565E-05	0	6.84069E-05	0.091467035	1.791E-05	0.332463973	5.9E-06	0.03409832	5.84E-05	0	0.0002028	0	6.94E-05	0.027175692	0.0003727	12.91294121	14.03201503	0.007016008
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.00073771	11.2247977	0.000835096	0.21249949	0.00054483	0	0.000735917	0.983996582	0.0031497	58.47439756	0.000731	4.22180307	0.000761	0	0.0018663	0	0.191633	75.03971963	0.00339774	117.7214576	267.8786716	0.133939336
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0.00569644	86.6757309	0.005745061	1.46189418	0.004207073	0	0.009511781	12.71822689	0.00249	46.22815477	0.000821	4.74127308	0.008115	0	0.0282032	0	0.00965	3.778701393	0.05182285	1795.507162	1951.111143	0.975555572
	Tom Green	0.00148245	22.5566016	2.96846E-05	0.00755358	0.001094854	0	4.95918E-05	0.066309257	1.095E-05	0.203284967	1.06E-05	0.06121455	0.000305	0	4.72E-05	0	1.05E-05	0.004105442	5.396E-05	1.869567173	24.76863658	0.012384318
	Upton	3.1166E-05	0.47421689	3.14322E-05	0.00799826	2.30176E-05	0	5.20405E-05	0.069583469	1.362E-05	0.252921685	4.49E-06	0.02594027	4.44E-05	0	0.0001543	0	5.28E-05	0.020673884	0.00028353	9.823509047	10.67484351	0.005337422
	Ward	0.01855953	282.397682	0.01871795	4.7629887	0.013707039	0	0.030990277	41.43717915	0.0081128	150.6156752	0.002674	15.4475135	0.02644	0	0.0918886	0	0.03144	12.31136446	0.16884373	5849.93117	6356.903572	3.178451786
	Webb	0.02001433	304.533576	0.000400768	0.10197989	0.014781473	0	0.000669531	0.895232158	0.0001478	2.744522372	0.000143	0.82644925	0.004115	0	0.0006373	0	0.000142	0.055427005	0.00072851	25.24076924	334.3979556	0.167198978
	Wharton	0.00014434	2.1962409	0.000178787	0.0454942	0.000106601	0	6.01986E-05	0.08049168	0.001094	20.30994546	0.000249	1.43564651	9.99E-05	0	6.336E-05	0	7.64E-05	0.029916019	0.00010492	3.635098676	27.73283345	0.013866417
	Wichita	0.00020763	3.15930099	0.000209406	0.05328555	0.000153346	0	0.000346701	0.463575056	9.076E-05	1.68500056	2.99E-05	0.1728178	0.000296	0	0.001028	0	0.000352	0.137732384	0.00188893	65.44562701	71.11733935	0.03555867
	Wilbarger	0.02861682	435.427173	0.000573025	0.14581254	0.021134796	0	0.000957307	1.280017835	0.0002114	3.924163752	0.000205	1.18167089	0.005884	0	0.0009112	0	0.000202	0.079250453	0.00104164	36.08967183	478.1277607	0.23906388
	Wise	0.00284449	43.2810933	0.002882008	0.73335872	0.002100781	0	0.00476997	6.377939726	0.0012561	23.31928973	0.000413	2.38703285	0.004182	0	0.0146143	0	0.004798	1.878785605	0.02576141	892.5559901	970.53349	0.485266745
	Young	0.00623586	94.8834103	0.006289085	1.60032692	0.004605458	0	0.010412491	13.9225678	0.0027258	50.60568776	0.000899	5.19024361	0.008883	0	0.0308739	0	0.010564	4.136522078	0.05673017	1965.531077	2135.869835	1.067934918
	Total	**1.12183722**	**17069.627**	**1.172570094**	**298.373389**	**1.090766584**	**0**	**1.189130767**	**1589.989792**	**1.62936**	**30249.39389**	**1.542363**	**8909.25083**	**1.359386**	**0**	**1.2316428**	**0**	**1.221806**	**478.4364729**	**1.52878695**	**52967.90364**	**111562.975**	**55.78148748**

Energy Savings by PCA (MWh)										
	American Electric Power - West (ERCOT) /PCA	Austin Energy/PCA	Brownsville Public Utils Board/PCA	Lower Colorado River Auhotrity /PCA	Reliant Energy HL&P/PCA	San Antonio Public Service Bd/PCA	South Texas Electric Coop INC/PCA	Texas Municipal Power Pool/PCA	Texas-New Mexico Power Co/PCA	TXU Electric/PCA
	15,215.78	254.46	0.00	1,337.10	18,565.20	5,776.37	0.00	0.00	391.58	34,647.01

Table 10: 2009 Totalized OSD Electricity Savings from IECC/IRC by PCA for Single-family Residences

PCA	Total Electricity Savings by PCA (MWh) 2009-TRY 1999
American Electric Power - West (ERCOT)/PCA	84.49
Austin Energy/PCA	1.81
Brownsville Public Utils Board/PCA	0.00
Lower Colorado River Authority/PCA	9.53
Reliant Energy HL&P/PCA	128.67
San Antonio Public Service Bd /PCA	41.43
South Texas Electric Coop Inc/PCA	0.00
Texas Municipal Power Pool/PCA	0.00
Texas-New Mexico Power Co/PCA	2.90
TXU Electric/PCA	256.62
El Paso Electric Co/PCA	0.18
Entergy Electric System/PCA	33.20
Total	558.85

Table 11: 2009 OSD NOx Reductions from IECC/IRC by PCA for Single-family Residences by County Using 2007 eGRID

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs/year)	Lower Colorado River Auhtority /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/ PCA	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.00957217	0.80871604	0.011806715	0.021395837	0.007069474	0	0.004263638	0.040639593	0.0710018	9.13589279	0.01614	0.668748427	0.006781	0	0.0051797	0	0.126288	0.36675943	0.008772	2.251010601	13.29316272	0.006646581
	Chambers	0.0218814	1.84867553	0.027103415	0.049116139	0.016160386	0	0.009125896	0.086985037	0.1658435	21.33930123	0.037677	1.561100236	0.015138	0	0.0096055	0	0.011582	0.03363489	0.015905	4.08164689	29.00045995	0.01450023
	Fort Bend	0.05569551	4.70550112	0.068987309	0.125017096	0.041133619	0	0.023228475	0.221406181	0.4221274	54.31570027	0.095902	3.973525263	0.038531	0	0.0244493	0	0.029479	0.08561212	0.040484	10.38916442	73.81592647	0.036907963
	Galveston	0.02755599	2.32809994	0.033893644	0.061421223	0.020351324	0	0.012791501	0.121924384	0.2014466	25.92040913	0.045813	1.898160221	0.019824	0	0.0167751	0	0.594657	1.72697167	0.028709	7.367509921	39.42449648	0.019712248
	Harris	0.07736057	6.53589933	0.09582276	0.173647638	0.057134232	0	0.032264145	0.307531222	0.5863312	75.44402608	0.133207	5.519191359	0.05352	0	0.0339599	0	0.040946	0.11891448	0.056232	14.43045726	102.5296674	0.051264834
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.00176365	0.14900396	0.003151138	0.005710414	0.001302533	0	0.005050143	0.0481363	0.0020858	0.268376418	0.000604	0.025028982	0.015958	0	0.0637888	0	0.000846	0.00245731	0.004013	1.029881936	1.528595313	0.000764298
	Dallas	0.00504555	0.42627949	0.005305276	0.00961409	0.003726366	0	0.008757286	0.083471574	0.0024131	0.310495113	0.000782	0.03241169	0.00931	0	0.033672	0	0.008209	0.02384069	0.044002	11.2919786	12.17809124	0.006089046
	Denton	0.00063576	0.05371275	0.001170951	0.002121968	0.000469535	0	0.001874207	0.017864325	0.0007854	0.10106244	0.000227	0.009392533	0.006096	0	0.0243999	0	0.00025	0.00072705	0.00114	0.292438059	0.477319128	0.00023866
	Tarrant	0.01557224	1.31563935	0.015705165	0.028460513	0.011500796	0	0.026002176	0.247844196	0.006807	0.87586389	0.002244	0.092968723	0.022184	0	0.0770985	0	0.02638	0.07661035	0.141667	36.35507075	38.99245778	0.019496229
	Ellis	0.00350282	0.29594019	0.003532723	0.006401914	0.002586991	0	0.005848935	0.055750125	0.0015312	0.197017005	0.000505	0.020912404	0.00499	0	0.0173426	0	0.005934	0.01723275	0.031867	8.177717138	8.770971522	0.004385486
	Johnson	0.00033718	0.02848672	0.000621017	0.001125392	0.00024902	0	0.000993991	0.009474397	0.0004166	0.053598763	0.00012	0.004981357	0.003233	0	0.0129406	0	0.000133	0.0003856	0.000604	0.155095386	0.253147606	0.000126574
	Kaufman	0.00649275	0.54854786	0.006548174	0.011866438	0.004795187	0	0.01084145	0.103337137	0.0028381	0.365186146	0.000936	0.038762746	0.009249	0	0.0321458	0	0.010999	0.03194222	0.059067	15.15802662	16.25766917	0.008128835
	Parker	0.00047595	0.04021133	0.000876616	0.001588583	0.000351511	0	0.0014031	0.013373888	0.000588	0.075659046	0.00017	0.007031594	0.004564	0	0.0182667	0	0.000187	0.0005443	0.000853	0.218929847	0.35733859	0.000178669
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.00095027	0.08028477	0.000958382	0.001736757	0.000701818	0	0.001586741	0.015124293	0.0004154	0.053448182	0.000137	0.005673266	0.001354	0	0.0047048	0	0.00161	0.00467502	0.008645	2.218509607	2.379451901	0.001189726
	Hood	0.01232788	1.04153566	0.012433111	0.022530976	0.00910469	0	0.020584816	0.196207698	0.0053888	0.693384151	0.001776	0.07359938	0.017562	0	0.0610356	0	0.020884	0.06064915	0.112152	28.78076165	30.86866867	0.015434334
	Hunt	0.00635121	0.53658958	0.006405424	0.011607751	0.004690653	0	0.010605108	0.101084399	0.0027763	0.357225129	0.000915	0.037917723	0.009048	0	0.031445	0	0.010759	0.03124589	0.05778	14.82758333	15.9032538	0.007951627
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.03112811	2.62989544	0.048234164	0.08740876	0.0229895	0	0.084461674	0.805060907	0.0010637	0.136872166	1.065347	44.14075163	0.043667	0	0.0043501	0	0.000484	0.00140573	0.002333	0.598596721	48.39999135	0.024199996
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.00200761	0.16961535	0.076651484	0.138905924	0.00148271	0	0.134326688	1.280357822	0.0012416	0.15975196	0.003567	0.147812614	0.001066	0	0.0018623	0	0.000403	0.00117082	0.001842	0.472627454	2.370241942	0.001185121
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.00446951	0.37761222	0.170648096	0.309244261	0.003300936	0	0.299049574	2.850442202	0.002764	0.355653491	0.007942	0.329073097	0.002372	0	0.0041461	0	0.000898	0.00260657	0.0041	1.052203702	5.27683554	0.002638418
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.00246935	0.20862619	0.094281013	0.170853721	0.001823727	0	0.165221279	1.574834906	0.0015271	0.196494261	0.004388	0.181808913	0.001311	0	0.0022907	0	0.000496	0.0014401	0.002265	0.581329843	2.915387935	0.001457694
	Travis	0.00050761	0.04288596	0.298194277	0.540380298	0.000374892	0	0.033779905	0.321978943	0.0003331	0.042864941	0.000902	0.037366999	0.00027	0	0.0004695	0	0.000103	0.00029867	0.000465	0.119365309	1.105141112	0.000552571
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22352453	18.8847334	0.00447587	0.008111061	0.165082827	0	0.007477478	0.071272861	0.001651	0.212438473	0.001598	0.066205553	0.04596	0	0.0071176	0	0.001581	0.00459095	0.008136	2.087934025	21.33528631	0.010667643
	San Patricio	0.05533089	4.67469523	0.001107949	0.002007798	0.040864326	0	0.001850962	0.017642764	0.0004087	0.052586663	0.000396	0.016388412	0.011377	0	0.0017619	0	0.000391	0.00113644	0.002014	0.516843687	5.281300991	0.00264065
Victoria Area	Victoria	0.02060475	1.7408168	0.002090584	0.003788504	0.015217528	0	0.003408874	0.03249227	0.0011319	0.145648365	0.000524	0.021713284	0.495811	0	0.0305841	0	0.00045	0.00130673	0.002128	0.546000438	2.49176639	0.001245883
Other ERCOT counties	Andrews	2.5653E-05	0.0021673	2.58716E-05	4.68839E-05	1.89456E-05	0	4.28342E-05	0.000408282	1.121E-05	0.001442839	3.7E-06	0.00015315	3.65E-05	0	0.000127	0	4.35E-05	0.0001262	0.000233	0.059888891	0.064233545	3.21168E-05
	Angelina	0.00032149	0.02716148	0.000324234	0.000587569	0.000237435	0	0.000536817	0.005116763	0.0001405	0.018082278	4.63E-05	0.001919346	0.000458	0	0.0015917	0	0.000545	0.00158163	0.002925	0.750553245	0.805002304	0.000402501
	Bosque	0.00093945	0.07937077	0.001730301	0.003135609	0.000693828	0	0.002769496	0.026397926	0.0011606	0.149338912	0.000335	0.013879248	0.009008	0	0.0360555	0	0.00037	0.00107436	0.001684	0.432132663	0.705329487	0.000352665
	Brazos	0.00191393	0.16170033	0.003525105	0.006388108	0.00141352	0	0.005642234	0.053779916	0.0023645	0.304244891	0.000682	0.028275887	0.018351	0	0.073455	0	0.000754	0.00218877	0.003431	0.880374398	1.436952295	0.000718476
	Calhoun	0.08852525	7.47915991	0.001772635	0.003212326	0.065379841	0	0.0029614	0.028227093	0.0006539	0.084134697	0.000633	0.026220223	0.018202	0	0.0028189	0	0.000626	0.00181821	0.003222	0.826910931	8.449683392	0.004224842
	Cameron	0.05467229	4.61905275	0.001094762	0.0019839	0.285623104	0	0.001828931	0.017432764	0.0004038	0.051960729	0.000391	0.016193342	0.011242	0	0.0017409	0	0.000387	0.00112291	0.00199	0.510691743	5.218438139	0.002609219
	Cherokee	0.003513	0.29679954	0.003542982	0.006420503	0.002594504	0	0.005865919	0.055912012	0.0015356	0.197589104	0.000506	0.020973129	0.005005	0	0.0173929	0	0.005951	0.01728279	0.031959	8.201463635	8.796440714	0.00439822
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.0013551	0.11448717	2.71346E-05	4.91726E-05	0.001000801	0	4.53316E-05	0.000432086	1.001E-05	0.001287891	9.69E-06	0.000401366	0.000279	0	4.315E-05	0	9.58E-06	2.7832E-05	4.93E-05	0.012657931	0.129343447	6.46717E-05
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.00362926	0.30662262	0.003660242	0.006633001	0.002680373	0	0.006060061	0.057762514	0.0015864	0.204128645	0.000523	0.02166727	0.00517	0	0.0179686	0	0.006148	0.01785479	0.033017	8.472904761	9.087573599	0.004543787
	Fannin	0.00762852	0.64450419	0.007693632	0.01394221	0.005633999	0	0.012737922	0.121413686	0.0033346	0.429067396	0.001099	0.045543432	0.010867	0	0.0377689	0	0.012923	0.03752981	0.0694	17.80958857	19.1015893	0.009550795
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.00377443	0.31888752	0.003806652	0.006898321	0.002787588	0	0.006302464	0.060073014	0.0016499	0.212293791	0.000544	0.022533961	0.005377	0	0.0186873	0	0.006394	0.01856898	0.034338	8.811820951	9.451076543	0.004725538
	Frio	0.01476384	1.2473403	0.001497957	0.002714561	0.010903753	0	0.002442547	0.023281553	0.0008111	0.104360824	0.000375	0.01555813	0.355262	0	0.0219143	0	0.000322	0.0009363	0.001525	0.391223447	1.785415121	0.000892708
	Grimes	0.00055442	0.04684118	0.001021149	0.001850501	0.000409467	0	0.001634436	0.015578911	0.0006849	0.088133348	0.000198	0.00819093	0.005316	0	0.0212784	0	0.000218	0.00063404	0.000994	0.255025952	0.416254867	0.000208127
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.239737	20.2544631	0.004800509	0.008699365	0.177056459	0	0.008019827	0.076442357	0.0017708	0.22784686	0.001714	0.071007512	0.049294	0	0.0076338	0	0.001695	0.00492394	0.008726	2.239374088	22.88275719	0.011441379
	Howard	0.00058508	0.04943125	0.000590075	0.001069319	0.000432108	0	0.000976955	0.009312011	0.0002558	0.032907989	8.43E-05	0.003493024	0.000833	0	0.0028967	0	0.000991	0.00287841	0.005323	1.365933984	1.465025981	0.000732513
	Jack	0.00217756	0.18397357	0.002196145	0.0039798	0.001608224	0	0.003636037	0.034657508	0.0009519	0.122477187	0.000314	0.013000362	0.003102	0	0.0107811	0	0.003689	0.01071288	0.01981	5.083742856	5.45254416	0.002726272
	Jones	0.04250012	3.59067312	0.000851025	0.001542207	0.031388236	0	0.00142174	0.013551557	0.0003139	0.040392263	0.000304	0.012588078	0.008739	0	0.0013533	0	0.000301	0.00087291	0.001547	0.396992027	4.056612158	0.002028306
	Lamar	0.00107998	0.09124342	0.001089199	0.00197382	0.000797614	0	0.001803327	0.017188717	0.0004721	0.060743714	0.000156	0.006447652	0.001539	0	0.005347	0	0.00183	0.00531315	0.009825	2.521330138	2.704240617	0.00135212
	Limestone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Llano	0.00124346	0.10505518	0.047475864	0.086034587	0.000918351	0	0.083198331	0.793019135	0.000769	0.09894606	0.00221	0.09155115	0.00066	0	0.0011535	0	0.00025	0.00072517	0.001141	0.292732709	1.46806399	0.000734032
	McLennan	0.02303137	1.94583235	0.023227961	0.042093136	0.017009692	0	0.038457253	0.366561894	0.0100675	1.295403856	0.003319	0.137500864	0.03281	0	0.1140288	0	0.039015	0.11330681	0.209526	53.76919787	57.66989679	0.028834948
	Milam	0.00165249	0.13961275	0.001666598	0.003020167	0.001220439	0	0.002759294	0.026300679	0.0007223	0.092944744	0.000238	0.009865636	0.002354	0	0.0081815	0	0.002799	0.00812972	0.015033	3.857919903	4.137793596	0.002068897
	Mitchell	0.01696145	1.43300838	0.017106233	0.030999493	0.012526789	0	0.028321847	0.269954535	0.0074142	0.954000267	0.002444	0.101262522	0.024163	0	0.0839765	0	0.028733	0.08344481	0.154305	39.59832981	42.47099982	0.0212355
	Nolan	0.00060327	0.05096822	0.000608422	0.001102568	0.000445544	0	0.001007331	0.009601551	0.0002637	0.033931203	8.69E-05	0.003601633	0.000859	0	0.0029868	0	0.001022	0.00296791	0.005488	1.408405217	1.510578299	0.000755289
	Palo Pinto	0.00307488	0.25978481	0.00566337	0.010263019	0.002270935	0	0.00906471	0.086401836	0.0037988	0.488794316	0.001096	0.045427526	0.029483	0	0.1180115	0	0.001211	0.00351644	0.005512	1.414393521	2.308581464	0.001154291
	Pecos	4.2262E-05	0.00357054	4.26225E-05	7.72395E-05	3.12122E-05	0	7.05678E-05	0.000672629	1.847E-05	0.002377022	6.09E-06	0.000252309	6.02E-05	0	0.0002092	0	7.16E-05	0.00020791	0.000384	0.098664658	0.105822309	5.29112E-05
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.00035926	0.03035229	0.000406685	0.000736984	0.000265328	0	0.000358385	0.003416012	0.0015339	0.197364689	0.000356	0.014747333	0.000371	0	0.0009089	0	0.093323	0.27102523	0.001655	0.424626523	0.942269069	0.000471135
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tom Green	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upton	3.2238E-05	0.00272366	3.25131E-05	5.89195E-05	2.38092E-05	0	5.38302E-05	0.000513092	1.409E-05	0.00181323	4.65E-06	0.000192466	4.59E-05	0	0.0001596	0	5.46E-05	0.0001586	0.000293	0.07526295	0.080722918	4.03615E-05
	Ward	0.01980763	1.67347064	0.0199767	0.036201283	0.014628815	0	0.033074321	0.315253556	0.0086584	1.114083809	0.002854	0.118254617	0.028218	0	0.098068	0	0.033554	0.09744705	0.180198	46.2430249	49.59773585	0.024798868
	Webb	0.01418005	1.19801789	0.000283942	0.000514553	0.010472596	0	0.000474359	0.004521439	0.0001047	0.013476764	0.000101	0.004199977	0.002916	0	0.0004515	0	0.0001	0.00029124	0.000516	0.132455263	1.353477131	0.000676739
	Wharton	0.00015439	0.01304382	0.000191235	0.000346552	0.000114024	0	6.43902E-05	0.000613746	0.0011702	0.150565096	0.000266	0.011014757	0.000107	0	6.777E-05	0	8.17E-05	0.00023732	0.000112	0.028799142	0.204620432	0.00010231
	Wichita	0.00021984	0.01857369	0.000221719	0.000401795	0.000162364	0	0.000367089	0.003498969	9.61E-05	0.01236511	3.17E-05	0.001312497	0.000313	0	0.0010884	0	0.000372	0.00108156	0.002	0.513246914	0.55048053	0.00027524
	Wilbarger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Wise	0.00291847	0.24657046	0.002955932	0.005356667	0.002155421	0	0.004892446	0.046633187	0.0012878	0.165696919	0.000424	0.01755631	0.004281	0	0.0149528	0	0.004924	0.01430106	0.026441	6.785251186	7.281365785	0.003640683
	Young	0.00549666	0.46439182	0.005543579	0.010045936	0.004059529	0	0.009178198	0.087483563	0.0024027	0.309160735	0.000792	0.032815919	0.00783	0	0.0272141	0	0.009311	0.02704177	0.050005	12.83254227	13.76348202	0.006881741
	Total	**1.14303735**	**96.5708602**	**1.154658244**	**2.092443128**	**1.089429227**	**0**	**1.180868675**	**11.25565191**	**1.5393506**	**198.0703133**	**1.443965**	**59.82812797**	**1.481727**	**0**	**1.2697054**	**0**	**1.151969**	**3.34548944**	**1.517783**	**389.4981462**	**760.6610321**	**0.380330516**

Energy Savings by PCA (MWh)		84.49		1.81		0.00		9.53		128.67		41.43		0.00		0.00		2.90		256.62	

6.1.2 2009 Results for New Multi-family Residential Construction

In this section of the report, calculations are provided regarding the potential electricity reductions and associated emissions reductions from the implementation of the IECC/IRC to new multi-family residences in all the counties in ERCOT region as well as the 41 non-attainment and affected counties. To calculate the NOx emissions reductions from the implementation of the IECC/IRC in multi-family residences, new construction activity by county had to be determined. Energy savings attributable to the IECC/IRC then had to be modeled using the code-traceable, DOE-2 simulation that the Laboratory developed for the TERP. Next, these estimates were applied to the NAHB's survey data to determine the appropriate number of housing types. In addition, estimates of the NOx reduction potential from the electricity reductions in each county were calculated using the US EPA's 2007 eGRID database[25].

In Table 12 and Table 13, the 1999 and IECC/IRC code-compliant building characteristics for multi-family are shown for each county. The IECC/IRC code-compliant characteristics are the minimum building code characteristics required by the IECC/IRC for each county for multi-family residences (i.e., Type A.2). In Table 12 and Table 13, the rows are sorted first by the US EPA's non-attainment and affected designation, then alphabetically. Next, in the third column, the location of the TMY2 weather file is listed, followed by the NAHB survey classification. The fifth column in Table 12 and Table 13 lists the window area for the average house as defined by the NAHB survey[26]. The sixth, seventh, eighth and ninth columns show the NAHB's average glazing U-value, Solar Heat Gain Coefficient (SHGC), roof insulation and wall insulation, respectively. In columns ten through fourteen of Table 12 and Table 13, the corresponding values from the IECC/IRC code-compliant house are listed for each county (i.e., percent area, glazing U-value, SHGC, roof and wall insulation R-value). For each county the identical window percent area was used for the 1999 and code-compliant calculation (i.e., window-to-wall area).

The IECC/IRC SHGC is 0.4 for all non-attainment and affected counties since they all fall below the 3,500 HDD_{65}, as required by the IECC/IRC. All houses were assumed to have air conditioner efficiency[27] equal to a SEER 11, and furnace efficiency (AFUE) or 0.80. The values shown in Table 12 and Table 13 represent the only changes that were made to the simulation to obtain the savings calculations. All other variables in the simulation remained the same for the 1999 and IECC/IRC code-compliant simulation. In cases where the 1999 values were more efficient than the IECC/IRC code-compliant simulation, the 1999 values were used in both simulations, since this indicates that the prevailing practice is already above code.

In Table 14 and Table 15, the code-traceable simulation results for multi-family are shown for each county. In a similar fashion as Table 12 and Table 13, this table is first divided into US EPA affected and then non-attainment classifications, followed by an alphabetical listing of counties. In the third column, the IECC/IRC climate zone is listed followed by the number of projected new housing units[28] in the fourth column. In the fifth column, the total simulated energy use is listed if all new construction had been built to pre-code specifications, and, in the sixth column, the total county-wide energy use for code-compliant construction is shown. In a similar fashion as the 2008 report, the values in the fifth and sixth columns come from the associated tables in the 2008 Volume III Appendix to the 2008 Volume II Technical report. As previously explained, in the 2008 report, 18 simulations were run for each county, which were then distributed according to the NAHB's survey data to account for 1, 2 or 3 story, and 3 fuel options (i.e., central air conditioning with electric resistance heating, heat pump heating, or a natural gas-fired furnace).

In the seventh and eighth columns, the total pre-code and code-compliant peak-day energy use is reported for peak OSD, Episode Day for the 2009 annual report across all counties. In a similar fashion as the annual

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[25] This analysis assumes transmission and distribution losses of 7%. Counties were assigned to utility service districts as indicated in a fashion similar to the 2004 report.

[26] In a similar fashion as single-family, this value represents the NAHB's reported number of window units times an average window size of 3 x 5 feet, which was determined by surveying local building suppliers. Additional information about the procedures used to determine these values can be found in Im (2003).

[27] In a similar fashion as single-family, the choice of a SEER 11 efficiency for the air conditioner was based on ARI sales numbers for Texas which show an average SEER 11 for houses built in 1999.

[28] The number of projected new housing units uses the published values for the new housing units in 2006. A vacancy rate of 0% was assumed for 2006 calculations, based on information suggested by the Real Estate Center at Texas A&M University.

pre-code and code-compliant energy use, these values are from the associated tables for each county in the Volume III Appendix to this report.

In the ninth and tenth columns, the total annual electricity and Ozone Season Day savings are shown for each county, respectively. In similar fashion as the 2008 report, a 7% transmission and distribution loss is used in the 2009 report, which represents a fixed 1.07 multiplier for the electricity use. In the eleventh and twelfth columns, the total annual pre-code and code-compliant natural gas use is shown for those residences that had natural gas-fired furnaces and domestic water heaters. Similarly, in columns thirteen and fourteen, the simulated total peak OSD natural gas use on the OSD, is shown for each county. Finally, in columns fifteen and sixteen, the total annual and peak-day natural gas savings are shown for each county.

In Table 16, the annual electricity savings from Table 14 and Table 15 are assigned to PCA provider(s) in a similar fashion as the single-family residential assignments. The total electricity savings for each PCA, as shown in Table 16 and Table 18, are then entered into the bottom row of Table 17 and Table 19, respectively, the 2007 US EPA eGRID database for Texas. eGRID then proportions each MWh of electricity savings according to the 1999 measured data from the power plants assigned to that PCA. For each county in which there is a power plant, the lbs-NOx/MWh are calculated and displayed as NOx reductions (lbs) in the column adjacent to the PCA column. In a similar fashion as the single-family residences, adding across the rows then totals the NOx reductions in each county from multiple PCAs that have power plants in that county. Counties that do not show NOx reductions represent counties that do not have power plants in eGRID's database. In Table 18, the PCA assignments for peak OSD reductions are shown for each county, and, in Table 19, the peak OSD NOx reductions are shown calculated with the 2007 eGRID.

Table 12: 1999 and IECC/IRC Code-compliant Building Characteristics used in the DOE-2 Simulations for Multi-family Residential (1)

			1999 Average					2000 IECC				
		Climate Zone	Area %	Glazing U-value (Btu/ hr-ft2-F)	SHGC	Roof Insulation (hr-ft2-F/Btu)	Wall Insulation (hr-ft2-F/Btu)	Area %	Glazing U-value (Btu/ hr-ft2-F)	SHGC	Roof Insulation (hr-ft2-F/Btu)	Wall Insulation (hr-ft2-F/Btu)
Non-attainment	BRAZORIA	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	CHAMBERS	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	COLLIN	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	DALLAS	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	DENTON	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	EL PASO	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	FORT BEND	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	GALVESTON	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	HARDIN	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	HARRIS	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	JEFFERSON	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	LIBERTY	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	MONTGOMERY	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	ORANGE	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	TARRANT	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	WALLER	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
Affected	BASTROP	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	BEXAR	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	CALDWELL	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	COMAL	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	ELLIS	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	GREGG	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	GUADALUPE	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	HARRISON	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	HAYS	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	HENDERSON	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	HOOD	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	HUNT	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	JOHNSON	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	KAUFMAN	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	NUECES	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	PARKER	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	ROCKWALL	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	RUSK	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	SAN PATRICIO	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	SMITH	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	TRAVIS	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	UPSHUR	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	VICTORIA	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	WILLIAMSON	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	WILSON	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
ERCOT	ANDERSON	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	ANDREWS	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	ANGELINA	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	ARANSAS	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	ARCHER	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	ATASCOSA	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	AUSTIN	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	BANDERA	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	BAYLOR	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	BEE	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	BELL	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	BLANCO	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	BORDEN	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	BOSQUE	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	BRAZOS	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	BREWSTER	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	BRISCOE	8	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	BROOKS	2	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	BROWN	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	BURLESON	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	BURNET	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	CALHOUN	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	CALLAHAN	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	CAMERON	2	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	CHEROKEE	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	CHILDRESS	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	CLAY	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	COKE	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	COLEMAN	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	COLORADO	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	COMANCHE	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	CONCHO	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	COOKE	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	CORYELL	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	COTTLE	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	CRANE	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	CROCKETT	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	CROSBY	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	CULBERSON	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	DAWSON	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	DE WITT	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	DELTA	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	DICKENS	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	DIMMIT	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	DUVAL	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	EASTLAND	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	ECTOR	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	EDWARDS	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	ERATH	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	FALLS	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	FANNIN	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	FAYETTE	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	FISHER	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	FOARD	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	FRANKLIN	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	FREESTONE	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00

Table 13: 1999 and IECC/IRC Code-compliant Building Characteristics used in the DOE-2 Simulation for Multi-family Residential (2)

		Climate Zone	1999 Average					2000 IECC				
			Area %	Glazing U-value (Btu/ hr-ft2-F)	SHGC	Roof Insulation (hr-ft2-F/Btu)	Wall Insulation (hr-ft2-F/Btu)	Area %	Glazing U-value (Btu/ hr-ft2-F)	SHGC	Roof Insulation (hr-ft2-F/Btu)	Wall Insulation (hr-ft2-F/Btu)
	FRIO	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	GILLESPIE	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	GLASSCOCK	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	GOLIAD	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	GONZALES	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	GRAYSON	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	GRIMES	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	HALL	8	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	HAMILTON	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	HARDEMAN	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	HASKELL	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	HIDALGO	2	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	HILL	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	HOPKINS	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	HOUSTON	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	HOWARD	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	HUDSPETH	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	IRION	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	JACK	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	JACKSON	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	JEFF DAVIS	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	JIM HOGG	2	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	JIM WELLS	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	JONES	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	KARNES	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	KENDALL	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	KENEDY	2	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	KENT	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	KERR	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	KIMBLE	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	KING	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	KINNEY	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	KLEBERG	2	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	KNOX	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	LA SALLE	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	LAMAR	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	LAMPASAS	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	LAVACA	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	LEE	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	LEON	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	LIMESTONE	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	LIVE OAK	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	LLANO	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	LOVING	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	MADISON	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	MARTIN	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	MASON	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	MATAGORDA	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	MAVERICK	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	MCCULLOCH	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	MCLENNAN	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	MCMULLEN	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
ERCOT	MEDINA	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	MENARD	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	MIDLAND	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	MILAM	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	MILLS	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	MITCHELL	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	MONTAGUE	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	MOTLEY	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	NACOGDOCHES	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	NAVARRO	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	NOLAN	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	PALO PINTO	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	PECOS	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	PRESIDIO	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	RAINS	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	REAGAN	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	REAL	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	RED RIVER	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	REEVES	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	REFUGIO	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	ROBERTSON	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	RUNNELS	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	SAN SABA	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	SCHLEICHER	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	SCURRY	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	SHACKELFORD	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	SOMERVELL	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	STARR	2	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	STEPHENS	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	STERLING	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	STONEWALL	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	SUTTON	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	TAYLOR	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	TERRELL	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	THROCKMORTON	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	TITUS	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	TOM GREEN	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	UPTON	5	7.5%	0.75	0.61	36.08	21.41	7.5%	0.70	0.40	19.00	11.00
	UVALDE	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	VAL VERDE	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	VAN ZANDT	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	WARD	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	WASHINGTON	4	7.5%	0.75	0.61	36.08	21.41	7.5%	0.85	0.40	19.00	11.00
	WEBB	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	WHARTON	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	WICHITA	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	WILBARGER	7	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	WILLACY	2	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	WINKLER	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	WISE	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	YOUNG	6	7.5%	0.75	0.61	36.08	21.41	7.5%	0.55	0.40	30.00	13.00
	ZAPATA	2	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00
	ZAVALA	3	7.5%	0.75	0.61	36.08	21.41	7.5%	any	0.40	19.00	11.00

Table 14: 2009 Annual and OSD Electricity and Natural Gas Savings from Implementation of the IECC/IRC for Multi-family Residences (1)

2009 Summary TRY 1999

	County	Climate Zone	No. of Projected Units (2006)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Precode OSD Elec. Use (MWh/day)	Code-compliant OSD Elec. Use (MWh/day)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Total OSD Elec. Savings (MWh/day) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Precode OSD NG Use (Therm/day)	Code-compliant OSD NG Use (Therm/day)	Total Annual NG Savings (Therm/yr)	Total OSD NG Savings (Therm/day)
Affected County	BASTROP	4	23	383	355	1.76	1.57	29	0.21	5,491	5,287	8.76	8.33	204	0.43
	BEXAR	4	3,625	55,406	51,771	249.39	223.29	3,890	27.93	1,056,129	1,016,474	1,538.99	1,465.82	39,656	73.17
	CALDWELL	4	20	325	301	1.52	1.35	25	0.18	5,179	4,984	8.31	7.91	194	0.40
	COMAL	4	826	12,625	11,797	56.83	50.88	886	6.36	240,652	231,616	350.68	334.01	9,036	16.67
	ELLIS	5	475	7,949	7,406	38.12	33.88	582	4.53	199,099	192,084	192.06	182.47	7,015	9.59
	GREGG	6	157	2,448	2,312	10.91	9.83	145	1.15	52,068	49,186	58.20	55.29	2,882	2.91
	GUADALUPE	4	813	12,426	11,611	55.93	50.08	872	6.26	236,864	227,971	345.16	328.75	8,894	16.41
	HARRISON	6	41	637	602	2.82	2.55	37	0.30	13,755	13,001	15.20	14.44	755	0.76
	HAYS	5	1,009	16,390	15,188	76.65	68.07	1,285	9.18	260,814	251,078	419.18	398.81	9,736	20.37
	HENDERSON	5	50	775	732	3.43	3.09	45	0.36	16,829	15,932	18.53	17.61	897	0.93
	HOOD	5	41	686	639	3.29	2.92	50	0.39	17,185	16,580	16.58	15.75	606	0.83
	HUNT	6	46	771	718	3.69	3.28	56	0.44	19,338	18,662	18.60	17.67	676	0.93
	JOHNSON	5	515	8,619	8,029	41.33	36.74	631	4.91	215,865	208,259	208.23	197.84	7,606	10.39
	KAUFMAN	6	136	2,283	2,137	10.94	9.76	157	1.26	57,057	54,202	54.99	52.24	2,855	2.75
	NUECES	3	793	12,377	11,506	50.01	44.81	931	5.57	157,091	150,938	310.48	295.81	6,153	14.67
	PARKER	6	334	5,608	5,247	26.87	23.98	385	3.10	140,126	133,114	135.05	128.31	7,012	6.74
	ROCKWALL	6	545	9,150	8,562	43.84	39.12	629	5.05	228,648	217,207	220.36	209.36	11,442	11.00
	RUSK	5	6	85	80	0.35	0.32	5	0.04	1,976	1,906	2.43	2.32	70	0.11
	SAN PATRICIO	3	159	2,482	2,307	10.03	8.98	187	1.12	31,498	30,264	62.25	59.31	1,234	2.94
	SMITH	5	160	2,480	2,340	10.98	9.88	150	1.17	53,852	51,437	59.31	56.35	2,415	2.96
	TRAVIS	5	3,661	59,468	55,109	278.10	246.98	4,664	33.30	946,322	910,996	1,520.92	1,447.03	35,326	73.89
	UPSHUR	6	8	140	131	0.65	0.58	9	0.07	3,113	2,946	2.97	2.82	166	0.15
	VICTORIA	3	46	652	615	2.72	2.45	41	0.29	10,795	10,401	18.45	17.60	394	0.85
	WILLIAMSON	5	1,965	31,919	29,579	149.27	132.56	2,503	17.87	507,927	488,967	816.34	776.68	18,961	39.66
	WILSON	4	27	413	386	1.86	1.66	29	0.21	7,866	7,571	11.46	10.92	295	0.54
Nonattain-ment County	BRAZORIA	3	1,496	22,179	20,754	94.40	84.52	1,525	10.57	328,691	315,930	577.25	549.57	12,761	27.68
	CHAMBERS	4	257	3,816	3,572	16.09	14.42	261	1.78	57,014	54,822	100.96	96.21	2,192	4.76
	COLLIN	6	3,392	56,949	53,039	272.87	242.54	4,183	32.45	1,423,073	1,373,258	1,371.50	1,303.03	49,815	68.46
	DALLAS	5	2,701	45,203	42,111	216.74	192.67	3,308	25.75	1,132,139	1,092,249	1,092.10	1,037.59	39,889	54.52
	DENTON	6	2,469	41,453	38,790	198.62	177.23	2,849	22.88	1,035,840	984,006	998.30	948.46	51,834	49.83
	EL PASO	6	2,640	40,177	38,133	152.77	140.06	2,188	13.60	1,025,169	968,218	1,161.81	1,108.52	56,951	53.29
	FORT BEND	4	4,845	71,884	67,260	306.08	274.02	4,948	34.31	1,064,512	1,023,040	1,869.50	1,779.84	41,472	89.65
	GALVESTON	3	1,140	16,901	15,815	71.94	64.41	1,162	8.06	250,473	240,749	439.88	418.79	9,725	21.09
	HARDIN	4	126	1,873	1,753	7.90	7.08	129	0.87	27,953	26,880	49.50	47.17	1,072	2.33
	HARRIS	4	11,591	171,973	160,910	732	656	11,837	82.08	2,546,700	2,447,482	4,472.51	4,258.03	99,217	214.48
	JEFFERSON	4	1,205	17,919	16,770	76	68	1,230	8.37	267,324	257,069	473.38	451.08	10,255	22.30
	LIBERTY	4	231	3,431	3,210	15	13	237	1.64	50,747	48,777	89.13	84.86	1,971	4.27
	MONTGOMERY	4	2,773	41,142	38,496	175.18	156.83	2,832	19.64	609,266	585,529	1,069.99	1,018.68	23,736	51.31
	ORANGE	4	319	4,743	4,439	20	18	325	2.22	70,769	68,054	125.32	119.42	2,715	5.90
	TARRANT	5	4,465	74,725	69,614	358	319	5,468	42.57	1,871,529	1,805,588	1,805.35	1,715.22	65,941	90.12
	WALLER	4	6	89	83	0.38	0.34	6	0.04	1,318	1,267	2.32	2.20	51	0.11
ERCOT	ANDERSON	5	13	184	174	0.76	0.68	10	0.08	4,281	4,131	5.27	5.03	151	0.24
	ANDREWS	6	46	677	594	2.64	2.17	89	0.50	23,164	21,664	21.46	20.54	1,500	0.93
	ANGELINA	5	52	735	697	3.02	2.73	40	0.31	17,125	16,522	21.07	20.11	603	0.96
	ARANSAS	3	97	1,514	1,407	6.12	5.48	114	0.68	19,215	18,463	37.98	36.18	753	1.79
	ARCHER	7	9	150	130	0.68	0.54	22	0.14	5,378	4,844	3.99	3.81	535	0.18
	ATASCOSA	3	32	476	416	2.20	1.80	64	0.42	8,532	8,474	13.41	12.76	59	0.65
	AUSTIN	4	30	445	416	1.90	1.70	31	0.21	6,591	6,335	11.58	11.02	257	0.56
	BANDERA	5	1	15	13	0.07	0.06	2	0.01	266	253	0.42	0.40	13	0.02
	BAYLOR	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	BEE	3	4	57	53	0.24	0.21	4	0.02	939	904	1.60	1.53	34	0.07
	BELL	5	1,841	30,213	25,902	147.84	117.95	4,613	31.98	762,865	740,063	809.58	772.42	22,802	37.16
	BLANCO	5	7	114	105	0.53	0.47	9	0.06	1,809	1,742	2.91	2.77	68	0.14
	BORDEN	7	19	283	252	0.97	0.81	33	0.17	11,894	10,689	8.55	8.20	1,205	0.35
	BOSQUE	5	4	66	56	0.32	0.26	10	0.07	1,658	1,608	1.76	1.68	50	0.08
	BRAZOS	4	707	10,490	9,815	44.66	39.99	722	5.01	155,337	149,286	272.80	259.72	6,052	13.08
	BREWSTER	5	20	306	266	1.27	1.03	43	0.26	10,152	9,851	8.89	8.49	301	0.40
	BRISCOE	8	7	102	92	0.31	0.27	11	0.04	6,943	5,889	3.58	3.44	1,054	0.14
	BROOKS	2	4	69	59	0.30	0.25	11	0.06	777	765	1.50	1.43	12	0.07
	BROWN	5	108	1,772	1,520	8.67	6.92	271	1.88	44,753	43,415	47.49	45.31	1,338	2.18
	BURLESON	4	12	178	167	0.76	0.68	12	0.08	2,637	2,534	4.63	4.41	103	0.22
	BURNET	5	235	3,817	3,537	17.85	15.85	299	2.14	60,744	58,477	97.63	92.89	2,268	4.74
	CALHOUN	3	60	851	802	3.55	3.20	53	0.37	14,080	13,567	24.06	22.95	514	1.11
	CALLAHAN	6	12	189	165	0.82	0.66	26	0.16	6,325	5,875	5.40	5.16	449	0.24
	CAMERON	2	939	16,223	13,910	70.97	58.38	2,475	13.47	182,421	179,616	352.23	334.86	2,805	17.38
	CHEROKEE	5	10	141	134	0.58	0.53	8	0.06	3,293	3,177	4.05	3.87	116	0.19
	CHILDRESS	7	6	90	80	0.31	0.25	11	0.05	3,756	3,376	2.70	2.59	380	0.11
	CLAY	7	2	33	29	0.15	0.12	5	0.03	1,195	1,076	0.89	0.85	119	0.04
	COKE	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	COLEMAN	5	1	16	14	0.07	0.05	2	0.01	529	514	0.45	0.43	15	0.02
	COLORADO	4	12	178	167	0.76	0.68	12	0.08	2,637	2,534	4.63	4.41	103	0.22
	COMANCHE	5	3	49	42	0.24	0.19	8	0.05	1,243	1,206	1.32	1.26	37	0.06
	CONCHO	5	1	15	13	0.06	0.05	2	0.01	508	493	0.44	0.42	15	0.02
	COOKE	6	28	469	437	2.25	2.00	34	0.27	11,771	11,359	11.32	10.76	411	0.57
	CORYELL	5	166	2,724	2,336	13.33	10.64	416	2.88	68,786	66,730	73.00	69.65	2,056	3.35
	COTTLE	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	CRANE	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	CROCKETT	5	19	290	252	1.21	0.98	41	0.25	9,644	9,358	8.45	8.07	286	0.38
	CROSBY	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	CULBERSON	6	9	127	111	0.50	0.42	17	0.09	3,144	2,952	4.00	3.82	192	0.18
	DAWSON	7	6	90	80	0.31	0.25	11	0.05	3,756	3,376	2.70	2.59	380	0.11
	DE WITT	3	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	DELTA	6	6	101	94	0.48	0.43	7	0.06	2,517	2,429	2.43	2.30	88	0.12
	DICKENS	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	DIMMIT	3	7	123	103	0.55	0.44	21	0.11	1,408	1,372	2.89	2.75	36	0.14
	DUVAL	3	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	EASTLAND	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	ECTOR	6	220	3,239	2,841	12.64	10.40	425	2.40	110,784	103,611	102.66	98.22	7,173	4.44
	EDWARDS	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	ERATH	6	31	489	425	2.11	1.71	68	0.42	16,338	15,178	13.96	13.34	1,160	0.63
	FALLS	5	4	66	56	0.32	0.26	10	0.07	1,658	1,608	1.76	1.68	50	0.08
	FANNIN	6	11	184	172	0.88	0.78	14	0.10	4,624	4,463	4.45	4.23	162	0.22
	FAYETTE	4	5	74	69	0.32	0.28	5	0.04	1,099	1,056	1.93	1.84	43	0.09
	FISHER	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	FOARD	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	FRANKLIN	6	2	34	31	0.16	0.14	2	0.02	839	810	0.81	0.77	29	0.04
	FREESTONE	5	5	82	70	0.40	0.32	13	0.09	2,072	2,010	2.20	2.10	62	0.10
	FRIO	3	12	178	156	0.82	0.68	24	0.16	3,200	3,178	5.03	4.79	22	0.24

Table 15: 2009 Annual and OSD Electricity and Natural Gas Savings from Implementation of the IECC/IRC for Multi-family Residences (2)

	County	Climate Zone	No. of Projected Units (2006)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Precode OSD Elec. Use (MWh/day)	Code-compliant OSD Elec. Use (MWh/day)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Total OSD Elec. Savings (MWh/day) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Precode OSD NG Use (Therm/day)	Code-compliant OSD NG Use (Therm/day)	Total Annual NG Savings (Therm/yr)	Total OSD NG Savings (Therm/day)
ERCOT	GILLESPIE	5	28	455	421	2.13	1.89	36	0.25	7,238	6,967	11.63	11.07	270	0.57
	GLASSCOCK	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	GOLIAD	3	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	GONZALES	4	1	15	14	0.07	0.06	1	0.01	291	280	0.42	0.40	11	0.02
	GRAYSON	6	108	1,810	1,686	8.66	7.70	133	1.03	45,402	43,815	43.67	41.49	1,587	2.18
	GRIMES	4	15	223	208	0.95	0.85	15	0.11	3,296	3,167	5.79	5.51	128	0.28
	HALL	8	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	HAMILTON	5	3	49	42	0.24	0.19	8	0.05	1,243	1,206	1.32	1.26	37	0.06
	HARDEMAN	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	HASKELL	6	1	16	14	0.07	0.06	2	0.01	527	490	0.45	0.43	37	0.02
	HIDALGO	2	2,793	48,256	41,375	211.09	173.64	7,363	40.07	542,599	534,257	1,047.70	996.02	8,342	51.68
	HILL	5	14	230	197	1.12	0.90	35	0.24	5,801	5,628	6.16	5.87	173	0.28
	HOPKINS	6	8	134	125	0.64	0.57	10	0.08	3,356	3,239	3.23	3.07	117	0.16
	HOUSTON	5	3	42	40	0.17	0.16	2	0.02	988	953	1.22	1.16	35	0.06
	HOWARD	6	2	29	26	0.11	0.09	4	0.02	1,007	942	0.93	0.89	65	0.04
	HUDSPETH	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	IRION	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	JACK	6	10	158	137	0.68	0.55	22	0.14	5,270	4,896	4.50	4.30	374	0.20
	JACKSON	3	7	99	94	0.41	0.37	6	0.04	1,643	1,583	2.81	2.68	60	0.13
	JEFF DAVIS	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	JIM HOGG	2	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	JIM WELLS	3	11	172	160	0.69	0.62	13	0.08	2,179	2,094	4.31	4.10	85	0.20
	JONES	6	1	16	14	0.07	0.06	2	0.01	527	490	0.45	0.43	37	0.02
	KARNES	3	51	782	677	3.67	2.99	113	0.73	12,719	12,576	21.81	20.78	143	1.03
	KENDALL	5	148	2,203	1,916	10.17	8.28	307	2.02	39,338	37,482	62.01	59.02	1,857	2.99
	KENEDY	2	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	KENT	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	KERR	5	46	747	692	3.49	3.10	59	0.42	11,890	11,447	19.11	18.18	444	0.93
	KIMBLE	5	1	15	13	0.06	0.05	2	0.01	508	493	0.44	0.42	15	0.02
	KING	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	KINNEY	4	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	KLEBERG	2	30	493	426	2.19	1.81	72	0.40	5,577	5,489	11.35	10.79	89	0.56
	KNOX	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	LA SALLE	3	6	105	88	0.47	0.38	18	0.09	1,207	1,176	2.48	2.35	31	0.12
	LAMAR	6	27	418	372	1.97	1.63	49	0.36	9,210	8,548	10.05	9.55	661	0.50
	LAMPASAS	5	15	246	211	1.20	0.96	38	0.26	6,216	6,030	6.60	6.29	186	0.30
	LAVACA	4	6	88	78	0.40	0.34	11	0.07	1,392	1,336	2.35	2.24	56	0.11
	LEE	4	7	114	105	0.53	0.47	9	0.06	1,813	1,745	2.91	2.77	68	0.14
	LEON	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	LIMESTONE	5	2	33	28	0.16	0.13	5	0.03	829	804	0.88	0.84	25	0.04
	LIVE OAK	3	8	125	116	0.50	0.45	9	0.06	1,585	1,523	3.13	2.98	62	0.15
	LLANO	5	136	2,209	2,047	10.33	9.17	173	1.24	35,154	33,842	56.50	53.75	1,312	2.75
	LOVING	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	MADISON	4	12	178	167	0.76	0.68	12	0.08	2,637	2,534	4.63	4.41	103	0.22
	MARTIN	6	1	15	13	0.06	0.05	2	0.01	504	471	0.47	0.45	33	0.02
	MASON	5	3	49	45	0.23	0.20	4	0.03	775	747	1.25	1.19	29	0.06
	MATAGORDA	3	79	1,120	1,055	4.67	4.22	70	0.49	18,539	17,863	31.68	30.22	676	1.46
	MAVERICK	3	101	1,771	1,489	7.89	6.42	302	1.58	20,316	19,791	41.67	39.63	525	2.04
	MCCULLOCH	5	1	15	13	0.06	0.05	2	0.01	508	493	0.44	0.42	15	0.02
	MCLENNAN	5	424	6,958	5,965	34.05	27.17	1,062	7.36	175,695	170,444	186.45	177.90	5,251	8.56
	MCMULLEN	3	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	MEDINA	4	14	214	200	0.96	0.86	15	0.11	4,079	3,926	5.94	5.66	153	0.28
	MENARD	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	MIDLAND	6	330	4,858	4,261	18.96	15.59	638	3.60	166,177	155,417	153.98	147.32	10,760	6.66
	MILAM	4	2	33	28	0.16	0.13	5	0.03	476	476	0.83	0.79	1	0.04
	MILLS	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	MITCHELL	6	1	16	14	0.07	0.06	2	0.01	527	490	0.45	0.43	37	0.02
	MONTAGUE	6	1	17	16	0.08	0.07	1	0.01	420	406	0.40	0.38	15	0.02
	MOTLEY	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	NACOGDOCHES	5	40	565	536	2.32	2.10	31	0.24	13,173	12,710	16.21	15.47	464	0.74
	NAVARRO	5	21	345	295	1.69	1.35	53	0.36	8,702	8,442	9.23	8.81	260	0.42
	NOLAN	6	1	16	14	0.07	0.06	2	0.01	527	490	0.45	0.43	37	0.02
	PALO PINTO	6	6	95	82	0.41	0.33	13	0.08	3,162	2,938	2.70	2.58	225	0.12
	PECOS	5	6	92	80	0.38	0.31	13	0.08	3,046	2,955	2.67	2.55	90	0.12
	PRESIDIO	5	5	76	66	0.32	0.26	11	0.07	2,538	2,463	2.22	2.12	75	0.10
	RAINS	6	3	50	47	0.24	0.21	4	0.03	1,259	1,215	1.21	1.15	44	0.06
	REAGAN	5	3	44	39	0.17	0.14	6	0.03	1,512	1,489	1.40	1.34	23	0.06
	REAL	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	RED RIVER	6	7	108	97	0.51	0.42	13	0.09	2,388	2,216	2.61	2.48	171	0.13
	REEVES	6	1	15	13	0.06	0.05	2	0.01	504	471	0.47	0.45	33	0.02
	REFUGIO	3	8	113	107	0.47	0.43	7	0.05	1,877	1,809	3.21	3.06	68	0.15
	ROBERTSON	4	8	119	111	0.51	0.45	8	0.06	1,758	1,689	3.09	2.94	68	0.15
	RUNNELS	5	2	31	27	0.13	0.10	4	0.03	1,015	985	0.89	0.85	30	0.04
	SAN SABA	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	SCHLEICHER	5	2	31	27	0.13	0.10	4	0.03	1,015	985	0.89	0.85	30	0.04
	SCURRY	7	3	45	40	0.15	0.13	5	0.03	1,878	1,688	1.35	1.29	190	0.06
	SHACKELFORD	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	SOMERVELL	5	29	485	452	2.33	2.07	36	0.28	12,156	11,727	11.73	11.14	428	0.59
	STARR	2	2	35	30	0.15	0.12	5	0.03	389	383	0.75	0.71	6	0.04
	STEPHENS	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	STERLING	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	STONEWALL	7	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	SUTTON	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	TAYLOR	6	201	3,172	2,757	13.67	11.12	443	2.73	105,936	98,414	90.53	86.48	7,522	4.06
	TERRELL	5	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	THROCKMORTO	6	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	TITUS	6	10	155	138	0.73	0.60	18	0.13	3,411	3,166	3.72	3.54	245	0.19
	TOM GREEN	5	181	2,767	2,403	11.51	9.30	390	2.36	91,876	89,149	80.50	76.85	2,727	3.65
	UPTON	5	1	15	13	0.06	0.05	2	0.01	504	496	0.47	0.45	8	0.02
	UVALDE	4	19	290	271	1.31	1.17	20	0.15	5,536	5,328	8.07	7.68	208	0.38
	VAL VERDE	4	44	673	628	3.03	2.71	47	0.34	12,819	12,338	18.68	17.79	481	0.89
	VAN ZANDT	6	13	218	203	1.05	0.93	16	0.12	5,454	5,263	5.26	4.99	191	0.26
	WARD	6	7	103	90	0.40	0.33	14	0.08	3,525	3,297	3.27	3.13	228	0.14
	WASHINGTON	4	82	1,217	1,138	5.18	4.64	84	0.58	18,017	17,315	31.64	30.12	702	1.52
	WEBB	3	668	11,713	9,850	52.20	42.45	1,994	10.43	134,368	130,893	275.57	262.09	3,475	13.48
	WHARTON	3	70	993	935	4.14	3.73	62	0.43	16,427	15,828	28.07	26.78	599	1.30
	WICHITA	7	161	2,689	2,320	12.10	9.72	395	2.55	96,211	86,649	71.37	68.12	9,562	3.25
	WILBARGER	7	1	17	14	0.08	0.06	2	0.02	598	538	0.44	0.42	59	0.02
	WILLACY	2	25	432	370	1.89	1.55	66	0.36	4,857	4,782	9.38	8.92	75	0.46
	WINKLER	6	1	15	13	0.06	0.05	2	0.01	504	471	0.47	0.45	33	0.02
	WISE	6	32	537	500	2.57	2.29	39	0.31	13,425	12,955	12.94	12.29	470	0.65
	YOUNG	6	5	79	69	0.34	0.28	11	0.07	2,635	2,448	2.25	2.15	187	0.10
	ZAPATA	2	0	0	0	0.00	0.00	0	0.00	0	0	0.00	0.00	0	0.00
	ZAVALA	3	8	140	118	0.63	0.51	24	0.12	1,609	1,568	3.30	3.14	42	0.16
	TOTAL		66,095					85,312	587					762,901	1,283

Table 16: 2009 Total Annual Electricity Savings from IECC/IRC by PCA for Multi-family Residences

PCA	Total Electricity Savings by PCA (MWh) 2009 TRY 1999
American Electric Power - West(ERCOT)/PCA	13,533.79
Austin Energy/PCA	457.86
Brownsville Public Utils Board/PCA	0.00
Lower Colorado River Authority/PCA	3,206.49
Reliant Energy HL&P/PCA	22,059.50
San Antonio Public Service Bd /PCA	3,264.84
South Texas Electric Coop Inc/PCA	0.00
Texas Municipal Power Pool/PCA	0.00
Texas-New Mexico Power Co/PCA	933.74
TXU Electric/PCA	78,188.65
El Paso Electric Co/PCA	13.45
Entergy Electric System/PCA	2,362.10
Total	124,020.41

Table 17: 2009 Annual NOx Reductions from IECC/IRC by PCA for Multi-family Residences by County using 2007 eGRID

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs/year)	Lower Colorado River Auhotrity /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/PCA	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.00883113	119.518654	0.010890729	4.98639146	0.006522185	0	0.003944232	12.6471296	0.0654443	1443.668549	0.014877	48.5724641	0.006262	0	0.0048171	0	0.121275	113.2387655	0.00816387	638.3219935	2380.953947	1.190476973
	Chambers	0.02176222	294.525257	0.026955801	12.3418897	0.016072371	0	0.009076193	29.10269844	0.1649402	3638.499395	0.037472	122.341102	0.015056	0	0.0095532	0	0.011519	10.75531786	0.01581859	1236.8344	5344.40006	2.67220003
	Fort Bend	0.07043123	953.20124	0.087239726	39.9432791	0.052016606	0	0.029374182	94.18794345	0.5338124	11775.63572	0.121275	395.944619	0.048726	0	0.030918	0	0.037279	34.80849972	0.05119528	4002.889586	17296.61089	8.648305444
	Galveston	0.03385674	458.209861	0.041710519	19.0974337	0.025004711	0	0.015351589	49.22467528	0.2495874	5505.773536	0.056747	185.27013	0.024143	0	0.0192972	0	0.567751	530.1296245	0.03283689	2567.471878	9315.177138	4.657588569
	Harris	0.06826733	923.915463	0.084559408	38.7160776	0.050418468	0	0.028471701	91.29415042	0.5174117	11413.84576	0.117549	383.779773	0.047229	0	0.0299681	0	0.036133	33.73905718	0.04962237	3879.906394	16765.19667	8.382598336
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.00203914	27.5972186	0.003716345	1.70155269	0.001505992	0	0.005950953	19.08165467	0.0024815	54.74017558	0.000717	2.34105703	0.019166	0	0.0766809	0	0.000864	0.807130677	0.0040002	312.7701886	419.0389779	0.209519489
	Dallas	0.00453947	61.4362307	0.004683963	2.14458291	0.003352602	0	0.00774211	24.82497776	0.0020856	46.00754656	0.000681	2.22355404	0.007503	0	0.026717	0	0.007525	7.026299217	0.04037045	3156.511339	3300.174531	1.650087265
	Denton	0.00047388	6.41339444	0.000872802	0.39961788	0.000349982	0	0.001396994	4.479443111	0.0005854	12.91458956	0.000169	0.55166196	0.004544	0	0.0181872	0	0.000187	0.174240225	0.00084941	66.41386137	91.34680854	0.045673404
	Tarrant	0.01216249	164.604568	0.012266309	5.61620996	0.008982543	0	0.020308652	65.11943669	0.0053165	117.2794471	0.001753	5.72165464	0.017326	0	0.0602168	0	0.020603	19.2381731	0.11064724	8651.358211	9028.9377	4.51446885
	Ellis	0.00327981	44.3882942	0.003307809	1.5145022	0.002422289	0	0.005476558	17.56051342	0.0014337	31.62630713	0.000473	1.54293707	0.004672	0	0.0162384	0	0.005556	5.187885737	0.02983782	2332.97921	2434.799649	1.217399825
	Johnson	0.00028606	3.87145424	0.000526868	0.24122988	0.000211267	0	0.000843297	2.7040219	0.0003534	7.795909475	0.000102	0.33301149	0.002743	0	0.0109787	0	0.000113	0.105180348	0.00051274	40.09081735	55.14162467	0.027570812
	Kaufman	0.00632545	85.6073204	0.006379446	2.92087086	0.004671629	0	0.010562096	33.86722836	0.002765	60.99453589	0.000911	2.97571039	0.009011	0	0.0313175	0	0.010715	10.00536299	0.05754527	4499.386651	4695.75768	2.34787884
	Parker	0.00021749	2.94345608	0.000400576	0.18340642	0.000160626	0	0.000641157	2.055860466	0.0002687	5.927208686	7.75E-05	0.25318772	0.002085	0	0.0083471	0	8.56E-05	0.079968331	0.00038984	30.48093896	41.92402666	0.020962013
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.00081989	11.0962825	0.000826893	0.37859856	0.000605529	0	0.001369042	4.389815396	0.0003584	7.906013149	0.000118	0.38570677	0.001168	0	0.0040593	0	0.001389	1.296878977	0.00745892	583.2032248	608.6565202	0.30432826
	Hood	0.01252711	169.539224	0.012634039	5.7845775	0.009251829	0	0.020917482	67.07164283	0.0054759	120.7953507	0.001805	5.89318329	0.017846	0	0.062022	0	0.021221	19.8149115	0.11396431	8910.716023	9299.614913	4.649807457
	Hunt	0.00618756	83.7410904	0.006240374	2.8571962	0.004569788	0	0.010331844	33.12892657	0.0027047	59.66486182	0.000892	2.91084023	0.008815	0	0.0306347	0	0.010482	9.787247192	0.05629078	4401.300525	4593.390688	2.296695344
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.03341375	452.214554	0.051775843	23.7059084	0.024677545	0	0.090663423	290.7111223	0.0011418	25.18845064	1.143572	3733.58056	0.046874	0	0.0046695	0	0.00052	0.485152605	0.00250387	195.7738407	4721.659586	2.360829793
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.00200047	27.0738945	0.076378745	34.9705076	0.001477434	0	0.133848731	429.1842649	0.0012371	27.29053402	0.003555	11.6058465	0.001062	0	0.0018557	0	0.000402	0.375098775	0.00183516	143.4890615	673.9892077	0.336994604
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.00450233	60.933622	0.171901148	78.7060647	0.003325174	0	0.301245466	965.939783	0.0027843	61.42119985	0.008001	26.1205961	0.00239	0	0.0041765	0	0.000904	0.844212752	0.0041303	322.9423915	1516.90787	0.758453935
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.0024586	33.2741546	0.093870431	42.9791908	0.001815785	0	0.164501762	527.472824	0.0015205	33.54040729	0.004369	14.2637304	0.001305	0	0.0022807	0	0.000494	0.461001081	0.00225544	176.3498494	828.3411574	0.414170579
	Travis	0.00051001	6.90232573	0.299602906	137.175149	0.000376663	0	0.033939476	108.826502	0.0003347	7.383509452	0.000906	2.95834151	0.000271	0	0.0004717	0	0.000103	0.096479993	0.00046734	36.54035338	299.8826612	0.149941331
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0.00068596	9.28370132	0.00069182	0.31675437	0.000506616	0	0.001145408	3.672737695	0.0002999	6.614563458	9.88E-05	0.32270145	0.000977	0	0.0033962	0	0.001162	1.085033396	0.00624051	487.9367979	509.2322895	0.254616145
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22756873	3079.86648	0.004556851	2.08638416	0.168069652	0	0.007612767	24.41024162	0.0016809	37.0795508	0.001627	5.31123109	0.046792	0	0.0072464	0	0.001609	1.502778598	0.00828339	647.6674581	3797.924122	1.898962061
	San Patricio	0.05031335	680.930126	0.001007478	0.46128033	0.037158653	0	0.001683113	5.39687971	0.0003716	8.197947339	0.00036	1.1742643	0.010345	0	0.0016021	0	0.000356	0.332250514	0.00183138	143.1933128	839.686061	0.419843031
Victoria Area	Victoria	0.02183674	295.533706	0.002215582	1.01441878	0.016127403	0	0.003612695	11.58406175	0.0011996	26.46304572	0.000555	1.8132564	0.525456	0	0.0324127	0	0.000477	0.445256888	0.00225485	176.3036143	513.1573602	0.25657868
Other ERCOT counties	Andrews	2.4742E-05	0.33485405	2.49533E-05	0.01142502	1.82731E-05	0	4.13138E-05	0.132472066	1.082E-05	0.238580851	3.57E-06	0.01163953	3.52E-05	0	0.0001225	0	4.19E-05	0.039136096	0.00022509	17.59940429	18.3675119	0.009183756
	Angelina	0.00031082	4.20657026	0.000313473	0.14352568	0.000229554	0	0.000519	1.664166977	0.0001359	2.997147902	4.48E-05	0.14622038	0.000443	0	0.0015389	0	0.000527	0.491643263	0.00282766	221.090743	230.7400175	0.115370009
	Bosque	0.00059539	8.05790478	0.001096604	0.50208714	0.000439723	0	0.001755208	5.628053353	0.0007356	16.22612393	0.000212	0.69311806	0.005709	0	0.0228507	0	0.000234	0.218918571	0.00106721	83.44357678	114.7697826	0.057384891
	Brazos	0.00193973	26.2518257	0.003572622	1.63574829	0.001432574	0	0.005718288	18.33561944	0.0023964	52.86304426	0.000692	2.25810741	0.018599	0	0.0744451	0	0.000764	0.713214206	0.00347685	271.8505979	373.9081572	0.186954079
	Calhoun	0.08269981	1119.24151	0.001655986	0.75820422	0.061077496	0	0.002766524	8.870824702	0.0006108	13.47492582	0.000591	1.93013247	0.017004	0	0.0026334	0	0.000585	0.54611854	0.00301023	235.3661457	1380.187859	0.690093929
	Cameron	0.04837175	654.652869	0.000968599	0.44347941	0.297964476	0	0.001618161	5.188612826	0.0003573	7.881586583	0.000346	1.12894916	0.009946	0	0.0015403	0	0.000342	0.319428887	0.00176071	137.6674484	807.2823743	0.403641187
	Cherokee	0.0035039	47.4210177	0.003533808	1.61797692	0.002587786	0	0.00585073	18.76029325	0.0015316	33.78709849	0.000505	1.64835454	0.004992	0	0.0173479	0	0.005936	5.54233555	0.03187642	2492.374402	2601.151479	1.300575739
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.00129879	17.5775036	2.6007E-05	0.01190747	0.000959212	0	4.34478E-05	0.139314842	9.593E-06	0.211621492	9.28E-06	0.03031241	0.000267	0	4.136E-05	0	9.19E-06	0.008576702	4.7275E-05	3.696386568	21.6756231	0.010837812
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.00353575	47.8520516	0.003565928	1.63268354	0.002611307	0	0.005903911	18.93081518	0.0015456	34.09420676	0.000509	1.66333728	0.005037	0	0.0175056	0	0.00599	5.592712681	0.03216616	2515.028872	2624.794679	1.312397339
	Fannin	0.00705631	95.4986527	0.007116546	3.25835724	0.005211403	0	0.011782473	37.78035178	0.0030845	68.04203161	0.001017	3.31953309	0.010052	0	0.034936	0	0.011954	11.16141331	0.06419422	5019.259583	5238.319922	2.619159961
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.00367718	49.7661337	0.003708565	1.69799089	0.00271576	0	0.006140067	19.68804779	0.0016074	35.45797503	0.00053	1.72987077	0.005238	0	0.0182058	0	0.006229	5.816421188	0.03345281	2615.630026	2729.786466	1.364893233
	Frio	0.00858833	116.232683	0.000871383	0.39896842	0.006342868	0	0.001420864	4.555983112	0.0004718	10.40785106	0.000218	0.7131493	0.206661	0	0.0127478	0	0.000188	0.175118443	0.00088683	69.33977965	201.8235328	0.100911766
	Grimes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.18852746	2551.49023	0.003775086	1.72844792	0.139235931	0	0.006306735	20.22246533	0.0013925	30.71825105	0.001348	4.40004602	0.038764	0	0.0060032	0	0.001333	1.244964657	0.00686231	536.5548164	3146.359224	1.573179612
	Howard	0.00055511	7.51278116	0.000559851	0.25633163	0.000409976	0	0.000926915	2.972141564	0.0002427	5.352796908	8E-05	0.26114427	0.000791	0	0.0027484	0	0.00094	0.878056949	0.00505009	394.8600085	412.0932609	0.20604663
	Jack	0.00212145	28.711231	0.002139557	0.97961013	0.001566784	0	0.003542346	11.35848911	0.0009273	20.45652405	0.000306	0.99800237	0.003022	0	0.0105033	0	0.003594	3.355627609	0.0192997	1509.017323	1574.876807	0.787438404
	Jones	0.04071872	551.07847	0.000815354	0.37331534	0.030072592	0	0.001362147	4.367708371	0.0003008	6.634619473	0.000291	0.95033506	0.008372	0	0.0012966	0	0.000288	0.268891179	0.00148214	115.8867094	679.5600486	0.339780024
	Lamar	0.00095084	12.8684359	0.000958954	0.43906338	0.000702236	0	0.001587687	5.0908994	0.0004156	9.168658351	0.000137	0.44730682	0.001355	0	0.0047076	0	0.001611	1.503999556	0.00865017	676.3448298	705.8631932	0.352931597
	Limestone	0.00071976	9.74103423	0.000891528	0.40819172	0.000531572	0	0.000300183	0.962533348	0.0054552	120.3385663	0.001239	4.04627053	0.000498	0	0.000316	0	0.000381	0.355717946	0.00052318	40.9066657	176.7589797	0.08837949
	Llano	0.00123817	16.7571812	0.047274044	21.6447299	0.000914447	0	0.082844655	265.6403394	0.0007657	16.89126865	0.0022	7.1833505	0.000657	0	0.0011486	0	0.000249	0.232164536	0.00113586	88.81146422	417.1604984	0.208580249
	McLennan	0.02453432	332.042198	0.024743738	11.3290823	0.018119687	0	0.040966843	131.3596652	0.0107245	236.577429	0.003535	11.5417865	0.034951	0	0.1214699	0	0.041562	38.80746065	0.22319886	17451.61776	18213.27538	9.106637692
	Milam	0.0022454	30.3888295	0.002264571	1.03684879	0.001658332	0	0.003749326	12.02216613	0.0009815	21.65179966	0.000324	1.05631569	0.003199	0	0.011117	0	0.003804	3.551697078	0.02042738	1597.189272	1666.896928	0.833448464
	Mitchell	0.01494317	202.237647	0.015070721	6.90022824	0.011036196	0	0.024951762	80.00751031	0.006532	144.0927172	0.002153	7.02978044	0.021288	0	0.073984	0	0.025314	23.63654249	0.1359442	10629.2939	11093.19833	5.546599164
	Nolan	0.00056465	7.64190235	0.000569473	0.26073716	0.000417022	0	0.000942846	3.023223374	0.0002468	5.444794732	8.14E-05	0.26563252	0.000804	0	0.0027956	0	0.000957	0.893147999	0.00513689	401.646416	419.1758542	0.209587927
	Palo Pinto	0.003207	43.4028291	0.005906709	2.70442538	0.002368511	0	0.009454195	30.31475852	0.003962	87.39985176	0.001144	3.73338797	0.03075	0	0.1230821	0	0.001263	1.179175674	0.00574838	449.4576937	618.1921221	0.309096061
	Pecos	4.0968E-05	0.5544478	4.13174E-05	0.01891743	3.02565E-05	0	6.84069E-05	0.219345846	1.791E-05	0.395039652	5.9E-06	0.0192726	5.84E-05	0	0.0002028	0	6.94E-05	0.064801134	0.0003727	29.14090763	30.41273209	0.015206366
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.00073771	9.98397854	0.000835096	0.38235434	0.00054483	0	0.000735917	2.359708757	0.0031497	69.48032728	0.000731	2.38619202	0.000761	0	0.0018663	0	0.191633	178.9341378	0.00339774	265.6645041	529.1912028	0.264595601
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0.00569644	77.094364	0.005745061	2.63041385	0.004207073	0	0.009511781	30.49940613	0.00249	54.92912209	0.000821	2.67980003	0.008115	0	0.0282032	0	0.00965	9.010410475	0.05182285	4051.959001	4228.802518	2.114401259
	Tom Green	0.00148245	20.0631346	2.96846E-05	0.01359131	0.001094854	0	4.95918E-05	0.159015323	1.095E-05	0.241546841	1.06E-05	0.03459888	0.000305	0	4.72E-05	0	1.05E-05	0.009789531	5.396E-05	4.219091795	24.74076828	0.012370384
	Upton	3.1166E-05	0.42179569	3.14322E-05	0.01439142	2.30176E-05	0	5.20405E-05	0.166867166	1.362E-05	0.300526079	4.49E-06	0.01466162	4.44E-05	0	0.0001543	0	5.28E-05	0.049297408	0.00028353	22.16892071	23.13646009	0.01156823
	Ward	0.01855953	251.180687	0.01871795	8.57013568	0.013707039	0	0.030990277	99.3699331	0.0081128	178.9642449	0.002674	8.73104049	0.02644	0	0.0918886	0	0.03144	29.3567646	0.16884373	13201.66344	13777.83625	6.888918124
	Webb	0.02001433	270.869621	0.000400768	0.18349435	0.014781473	0	0.000669531	2.146844005	0.0001478	3.261090676	0.000143	0.46711478	0.004115	0	0.0006373	0	0.000142	0.132167115	0.00072851	56.96137798	334.0217095	0.167010855
	Wharton	0.00014434	1.95346256	0.000178787	0.08185858	0.000106601	0	6.01986E-05	0.193025999	0.001094	24.13264123	0.000249	0.81143725	9.99E-05	0	6.336E-05	0	7.64E-05	0.071335515	0.00010492	8.203404093	35.44716523	0.017723583
	Wichita	0.00020763	2.81006342	0.000209406	0.09587769	0.000153346	0	0.000346701	1.111693008	9.076E-05	2.002147868	2.99E-05	0.0976778	0.000296	0	0.001028	0	0.000352	0.328426405	0.00188893	147.6925312	154.1384173	0.077069209
	Wilbarger	0.02861682	387.29389	0.000573025	0.26236327	0.021134796	0	0.000957307	3.069593279	0.0002114	4.662761708	0.000205	0.66788848	0.005884	0	0.0009112	0	0.000202	0.188974741	0.00104164	81.44432598	477.5897977	0.238794899
	Wise	0.00284449	38.4966856	0.002882008	1.31954622	0.002100781	0	0.00476997	15.29485011	0.0012561	27.70839803	0.000413	1.34916732	0.004182	0	0.0146143	0	0.004798	4.480012506	0.02576141	2014.249987	2102.898647	1.051449323
	Young	0.00623586	84.3947446	0.006289085	2.8794985	0.004605458	0	0.010412491	33.3875196	0.0027258	60.13058526	0.000899	2.93356125	0.008883	0	0.0308739	0	0.010564	9.863643085	0.05673017	4435.655567	4629.245119	2.31462256
	Total	**1.12183722**	**15182.7048**	**1.172570094**	**536.868884**	**1.090766584**	**0**	**1.189130767**	**3812.932793**	**1.62936**	**35942.87202**	**1.542363**	**5035.56961**	**1.359386**	**0**	**1.2316428**	**0**	**1.221806**	**1140.844052**	**1.52878695**	**119533.7888**	**181185.581**	**90.59279048**
Energy Savings by PCA (MWh)		13,533.79		457.86		0.00		3,206.49		22,059.50		3,264.84		0.00		0.00		933.74		78,188.65			

Table 18: 2009 Total OSD Electricity Savings from IECC/IRC by PCA for Multi-family Residences

PCA	Total Electricity Savings by PCA (MWh) 2009 TRY 1999
American Electric Power - West(ERCOT)/PCA	52.88
Austin Energy/PCA	2.28
Brownsville Public Utils Board/PCA	0.00
Lower Colorado River Authority/PCA	16.03
Reliant Energy HL&P/PCA	97.76
San Antonio Public Service Bd /PCA	15.93
South Texas Electric Coop Inc/PCA	0.00
Texas Municipal Power Pool/PCA	0.00
Texas-New Mexico Power Co/PCA	4.36
TXU Electric/PCA	380.87
El Paso Electric Co/PCA	0.06
Entergy Electric System/PCA	10.47
Total	580.64

Table 19: 2009 OSD NOx Reductions from IECC/IRC by PCA for Multi-family Residences by County using 2007 eGRID

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs/year)	Lower Colorado River Auhotrity /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/ PCA	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.00957217	0.5061912	0.011806715	0.026975917	0.007069474	0	0.004263638	0.068334345	0.0710018	6.941301348	0.01614	0.257042356	0.006781	0	0.0051797	0	0.126288	0.55118814	0.008772	3.340818207	11.69185151	0.005845926
	Chambers	0.0218814	1.15712219	0.027103415	0.061925732	0.016160386	0	0.009125896	0.14626292	0.1658435	16.21325072	0.037677	0.600029648	0.015138	0	0.0096055	0	0.011582	0.05054854	0.015905	6.05774146	24.28688122	0.012143441
	Fort Bend	0.05569551	2.94526524	0.068987309	0.157621821	0.041133619	0	0.023228475	0.372288335	0.4221274	41.2681773	0.095902	1.527277306	0.038531	0	0.0244493	0	0.029479	0.12866304	0.040484	15.41898987	61.81828292	0.030909141
	Galveston	0.02755599	1.45720331	0.033893644	0.077440009	0.020351324	0	0.012791501	0.20501246	0.2014466	19.69390129	0.045813	0.729583138	0.019824	0	0.0167751	0	0.594657	2.59539693	0.028709	10.93442708	35.69296422	0.017846482
	Harris	0.07736057	4.0909473	0.09582276	0.218935312	0.057134232	0	0.032264145	0.517105196	0.5863312	57.32113237	0.133207	2.121374636	0.05352	0	0.0339599	0	0.040946	0.17871183	0.056232	21.41684021	85.86504686	0.042932523
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.00176365	0.09326449	0.003151138	0.007199702	0.001302533	0	0.005050143	0.080939849	0.0020858	0.203907996	0.000604	0.009620222	0.015958	0	0.0637888	0	0.000846	0.00369299	0.004013	1.528490501	1.927115751	0.000963558
	Dallas	0.00504555	0.26681668	0.005305276	0.012121465	0.003726366	0	0.008757286	0.140355129	0.0024131	0.235909089	0.000782	0.012457864	0.00931	0	0.033672	0	0.008209	0.03582922	0.044002	16.75889384	17.46238328	0.008731192
	Denton	0.00063576	0.03361986	0.001170951	0.002675381	0.000469535	0	0.001874207	0.030038365	0.0007854	0.076785583	0.000227	0.003610145	0.006096	0	0.0243999	0	0.00025	0.00109266	0.00114	0.434019453	0.581841449	0.000290921
	Tarrant	0.01557224	0.82348442	0.015705165	0.035883075	0.011500796	0	0.026002176	0.416743121	0.006807	0.665467004	0.002244	0.035733766	0.022184	0	0.0770985	0	0.02638	0.11513465	0.141667	53.95606854	56.04851457	0.028024257
	Ellis	0.00350282	0.18523476	0.003532723	0.008071546	0.002586991	0	0.005848935	0.093742284	0.0015312	0.149690286	0.000505	0.008037961	0.00499	0	0.0173426	0	0.005934	0.02589841	0.031867	12.13688922	12.60756447	0.006303782
	Johnson	0.00033718	0.01783039	0.000621017	0.001418896	0.00024902	0	0.000993991	0.015930935	0.0004166	0.04072346	0.00012	0.001914651	0.003233	0	0.0129406	0	0.000133	0.0005795	0.000604	0.230183496	0.308581327	0.000154291
	Kaufman	0.00649275	0.34334684	0.006548174	0.014961231	0.004795187	0	0.01084145	0.173758521	0.0028381	0.277462438	0.000936	0.014898977	0.009249	0	0.0321458	0	0.010999	0.04800469	0.059067	22.49665607	23.36908877	0.011684544
	Parker	0.00047595	0.02516906	0.000876616	0.002002889	0.000351511	0	0.0014031	0.022487821	0.000588	0.057484501	0.00017	0.002702687	0.004564	0	0.0182667	0	0.000187	0.00081801	0.000853	0.324922867	0.43558783	0.000217794
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.00095027	0.05025181	0.000958382	0.002189707	0.000701818	0	0.001586741	0.025431077	0.0004154	0.040609052	0.000137	0.002180595	0.001354	0	0.0047048	0	0.00161	0.00702591	0.008645	3.292582134	3.420270282	0.001710135
	Hood	0.01232788	0.65191755	0.012433111	0.028407103	0.00910469	0	0.020584816	0.329917786	0.0053888	0.526821894	0.001776	0.028288901	0.017562	0	0.0610356	0	0.020884	0.0911472	0.112152	42.71472222	44.37122266	0.022185611
	Hunt	0.00635121	0.33586192	0.006405424	0.014635078	0.004690653	0	0.010605108	0.169970605	0.0027763	0.271413788	0.000915	0.014574181	0.009048	0	0.031445	0	0.010759	0.0469582	0.05778	22.00623148	22.85964525	0.011429823
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.03112811	1.64610302	0.048234164	0.11020515	0.0229895	0	0.084461674	1.353687521	0.0010637	0.103993224	1.065347	16.96608522	0.043667	0	0.0043501	0	0.000484	0.00211261	0.002333	0.888402224	21.07058897	0.010535294
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.00200761	0.10616557	0.076651484	0.175132885	0.00148271	0	0.134326688	2.152886063	0.0012416	0.121376917	0.003567	0.056813745	0.001066	0	0.0018623	0	0.000403	0.00175957	0.001842	0.701446009	3.31558076	0.00165779
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.00446951	0.23635488	0.170648096	0.389895823	0.003300936	0	0.299049574	4.792939274	0.002764	0.270219684	0.007942	0.126483623	0.002372	0	0.0041461	0	0.000898	0.00391731	0.0041	1.56161916	7.381429753	0.003690715
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.00246935	0.13058322	0.094281013	0.215412736	0.001823727	0	0.165221279	2.64804109	0.0015271	0.149293113	0.004388	0.069880675	0.001311	0	0.0022907	0	0.000496	0.00216427	0.002265	0.862775734	4.078150831	0.002039075
	Travis	0.00050761	0.02684316	0.298194277	0.681312631	0.000374892	0	0.033779905	0.541398637	0.0003331	0.032568078	0.000902	0.014362503	0.00027	0	0.0004695	0	0.000103	0.00044885	0.000465	0.177155006	1.474088868	0.000737044
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22352453	11.8203242	0.00447587	0.010226443	0.165082827	0	0.007477478	0.119843333	0.001651	0.161407264	0.001598	0.025446985	0.04596	0	0.0071176	0	0.001581	0.00689956	0.008136	3.098789496	15.24293729	0.007621469
	San Patricio	0.05533089	2.92598323	0.001107949	0.002531436	0.040864326	0	0.001850962	0.029665818	0.0004087	0.039954483	0.000396	0.006299104	0.011377	0	0.0017619	0	0.000391	0.0017079	0.002014	0.767069155	3.773211132	0.001886606
Victoria Area	Victoria	0.02060475	1.0896113	0.002090584	0.004776554	0.015217528	0	0.003408874	0.054634849	0.0011319	0.110661237	0.000524	0.00834579	0.495811	0	0.0305841	0	0.00045	0.00196383	0.002128	0.810341898	2.080335461	0.001040168
Other ERCOT counties	Andrews	2.5653E-05	0.00135655	2.58716E-05	5.91114E-05	1.89456E-05	0	4.28342E-05	0.000686515	1.121E-05	0.001096245	3.7E-06	5.88654E-05	3.65E-05	0	0.000127	0	4.35E-05	0.00018967	0.000233	0.088883588	0.092330542	4.61653E-05
	Angelina	0.00032149	0.0170009	0.000324234	0.000740809	0.000237435	0	0.000536817	0.008603694	0.0001405	0.013738618	4.63E-05	0.000737726	0.000458	0	0.0015917	0	0.000545	0.00237696	0.002925	1.113927205	1.157125915	0.000578563
	Bosque	0.00093945	0.04967972	0.001730301	0.003953383	0.000693828	0	0.002769496	0.044387378	0.0011606	0.113465254	0.000335	0.005334673	0.009008	0	0.0360555	0	0.00037	0.00161461	0.001684	0.641346011	0.859781029	0.000429891
	Brazos	0.00191393	0.1012114	0.003525105	0.008054141	0.00141352	0	0.005642234	0.090429432	0.0023645	0.231160273	0.000682	0.010868213	0.018351	0	0.073455	0	0.000754	0.00328941	0.003431	1.306600162	1.751613035	0.000875807
	Calhoun	0.08852525	4.68135256	0.001772635	0.004050107	0.065379841	0	0.0029614	0.047463072	0.0006539	0.063924161	0.000633	0.010078092	0.018202	0	0.0028189	0	0.000626	0.00273252	0.003222	1.227252813	6.036853323	0.003018427
	Cameron	0.05467229	2.89115552	0.001094762	0.002501305	0.285623104	0	0.001828931	0.029312708	0.0004038	0.039478909	0.000391	0.006224126	0.011242	0	0.0017409	0	0.000387	0.00168758	0.00199	0.7579388	3.728298939	0.001864149
	Cherokee	0.003513	0.18577264	0.003542982	0.008094984	0.002594504	0	0.005865919	0.094014493	0.0015356	0.150124957	0.000506	0.008061301	0.005005	0	0.0173929	0	0.005951	0.02597362	0.031959	12.17213238	12.64417438	0.006322087
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.0013551	0.07165976	2.71346E-05	6.1997E-05	0.001000801	0	4.53316E-05	0.000726541	1.001E-05	0.000978518	9.69E-06	0.00015427	0.000279	0	4.315E-05	0	9.58E-06	4.1828E-05	4.93E-05	0.018786161	0.092409074	4.62045E-05
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.00362926	0.1919211	0.003660242	0.008362902	0.002680373	0	0.006060061	0.09712606	0.0015864	0.155093593	0.000523	0.008328104	0.00517	0	0.0179686	0	0.006148	0.02683326	0.033017	12.57498942	13.06265443	0.006531327
	Fannin	0.00762852	0.40340779	0.007693632	0.017578368	0.005633999	0	0.012737922	0.204153736	0.0033346	0.325998363	0.001099	0.017505224	0.010867	0	0.0377689	0	0.012923	0.05640206	0.0694	26.43194916	27.45699469	0.013728497
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.00377443	0.19959794	0.003806652	0.008697418	0.002787588	0	0.006302464	0.101011102	0.0016499	0.161297337	0.000544	0.008661228	0.005377	0	0.0186873	0	0.006394	0.02790659	0.034338	13.077989	13.58516061	0.00679258
	Frio	0.01476384	0.78073471	0.001497957	0.003422524	0.010903753	0	0.002442547	0.039147283	0.0008111	0.079291641	0.000375	0.005979974	0.355262	0	0.0219143	0	0.000322	0.00140714	0.001525	0.580630947	1.49061421	0.000745307
	Grimes	0.00055442	0.02931881	0.001021149	0.002333115	0.000409467	0	0.001634436	0.026195505	0.0006849	0.066962271	0.000198	0.003148293	0.005316	0	0.0212784	0	0.000218	0.00095287	0.000994	0.378494595	0.507405467	0.000253703
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.239737	12.6776648	0.004800509	0.010968177	0.177056459	0	0.008019827	0.128535697	0.0017708	0.173114304	0.001714	0.027292682	0.049294	0	0.0076338	0	0.001695	0.00739999	0.008726	3.323547976	16.34852365	0.008174262
	Howard	0.00058508	0.03093999	0.000590075	0.0013482	0.000432108	0	0.000976955	0.015657887	0.0002558	0.025002949	8.43E-05	0.00134259	0.000833	0	0.0028967	0	0.000991	0.00432584	0.005323	2.027239285	2.10585674	0.001052928
	Jack	0.00217756	0.11515266	0.002196145	0.005017741	0.001608224	0	0.003636037	0.058275636	0.0009519	0.093056156	0.000314	0.004996862	0.003102	0	0.0107811	0	0.003689	0.01609995	0.01981	7.544993652	7.837592658	0.003918796
	Jones	0.04250012	2.24747258	0.000851025	0.001944418	0.031388236	0	0.00142174	0.022786567	0.0003139	0.030689378	0.000304	0.004838395	0.008739	0	0.0013533	0	0.000301	0.00131186	0.001547	0.589192334	2.898235526	0.001449118
	Lamar	0.00107998	0.05711105	0.001089199	0.002488596	0.000797614	0	0.001803327	0.02890235	0.0004721	0.046152077	0.000156	0.002478241	0.001539	0	0.005347	0	0.00183	0.00798492	0.009825	3.742010644	3.887127877	0.001943564
	Limestone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Llano	0.00124346	0.06575609	0.047475864	0.10847259	0.000918351	0	0.083198331	1.333439616	0.000769	0.075177592	0.00221	0.035188903	0.00066	0	0.0011535	0	0.00025	0.00108983	0.001141	0.434456757	2.053581382	0.001026791
	McLennan	0.02303137	1.21793455	0.023227961	0.053071115	0.017009692	0	0.038457253	0.616363629	0.0100675	0.984226582	0.003319	0.052850287	0.03281	0	0.1140288	0	0.039015	0.1702843	0.209526	79.80109696	82.89582742	0.041447914
	Milam	0.00165249	0.08738635	0.001666598	0.003807833	0.001220439	0	0.002759294	0.044223861	0.0007223	0.07061789	0.000238	0.003791988	0.002354	0	0.0081815	0	0.002799	0.01221783	0.015033	5.725698958	5.947744715	0.002973872
	Mitchell	0.01696145	0.89694799	0.017106233	0.039084227	0.012526789	0	0.028321847	0.453921041	0.0074142	0.72483374	0.002444	0.038921598	0.024163	0	0.0839765	0	0.028733	0.12540588	0.154305	58.76952385	61.04863833	0.030524319
	Nolan	0.00060327	0.03190201	0.000608422	0.00139012	0.000445544	0	0.001007331	0.016144741	0.0002637	0.025780371	8.69E-05	0.001384336	0.000859	0	0.0029868	0	0.001022	0.00446035	0.005488	2.090272604	2.171334526	0.001085667
	Palo Pinto	0.00307488	0.1626044	0.00566337	0.012939636	0.002270935	0	0.00906471	0.145282284	0.0037988	0.371377897	0.001096	0.017460674	0.029483	0	0.1180115	0	0.001211	0.00528471	0.005512	2.099160095	2.814109694	0.001407055
	Pecos	4.2262E-05	0.00223487	4.26225E-05	9.73837E-05	3.12122E-05	0	7.05678E-05	0.001131006	1.847E-05	0.001806022	6.09E-06	9.69785E-05	6.02E-05	0	0.0002092	0	7.16E-05	0.00031247	0.000384	0.146432312	0.152111038	7.60555E-05
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.00035926	0.01899809	0.000406685	0.000929192	0.000265328	0	0.000358385	0.005743929	0.0015339	0.14995445	0.000356	0.005668334	0.000371	0	0.0009089	0	0.093323	0.40731303	0.001655	0.630205837	1.218812864	0.000609406
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tom Green	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upton	3.2238E-05	0.00170479	3.25131E-05	7.42858E-05	2.38092E-05	0	5.38302E-05	0.000862749	1.409E-05	0.001377662	4.65E-06	7.39767E-05	4.59E-05	0	0.0001596	0	5.46E-05	0.00023835	0.000293	0.111700866	0.116032687	5.80163E-05
	Ward	0.01980763	1.04745802	0.0199767	0.045642654	0.014628815	0	0.033074321	0.530090085	0.0086584	0.846462587	0.002854	0.045452735	0.028218	0	0.098068	0	0.033554	0.14644929	0.180198	68.63119146	71.29274684	0.035646373
	Webb	0.01418005	0.74986285	0.000283942	0.000648749	0.010472596	0	0.000474359	0.007602673	0.0001047	0.010239424	0.000101	0.001614317	0.002916	0	0.0004515	0	0.0001	0.0004377	0.000516	0.19658235	0.966988056	0.000483494
	Wharton	0.00015439	0.00816438	0.000191235	0.000436933	0.000114024	0	6.43902E-05	0.001031997	0.0011702	0.114396888	0.000266	0.004233668	0.000107	0	6.777E-05	0	8.17E-05	0.00035666	0.000112	0.042742001	0.171362528	8.56813E-05
	Wichita	0.00021984	0.01162564	0.000221719	0.000506583	0.000162364	0	0.000367089	0.005883419	9.61E-05	0.009394807	3.17E-05	0.000504476	0.000313	0	0.0010884	0	0.000372	0.00162543	0.002	0.761731034	0.791271383	0.000395636
	Wilbarger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Wise	0.00291847	0.15433328	0.002955932	0.006753697	0.002155421	0	0.004892446	0.078412407	0.0012878	0.125893799	0.000424	0.006748001	0.004281	0	0.0149528	0	0.004924	0.02149249	0.026441	10.07027274	10.46390641	0.005231953
	Young	0.00549666	0.29067193	0.005543579	0.012665938	0.004059529	0	0.009178198	0.14710178	0.0024027	0.234895251	0.000792	0.012613235	0.00783	0	0.0272141	0	0.009311	0.04064	0.050005	19.04530829	19.78389583	0.009891948
	Total	**1.14303735**	**60.4455913**	**1.154658244**	**2.638156755**	**1.089429227**	**0**	**1.180868675**	**18.9260656**	**1.5393506**	**150.4905721**	**1.443965**	**22.99573704**	**1.481727**	**0**	**1.2697054**	**0**	**1.151969**	**5.02780281**	**1.517783**	**578.0703556**	**838.5942812**	**0.419297141**

Energy Savings by PCA (MWh)																				
		52.88		2.28		0.00		16.03		97.76		15.93		0.00		0.00		4.36		380.87

6.1.3 2009 Results for New Residential Construction (Single-family and Multi-family), using 1999 Base Year and 2007 eGRID

In Table 20 and Table 21, the combined NOx emissions reductions are listed from single-family electricity savings, multi-family electricity savings, and natural gas savings (single-family and multi-family), which also show the 2009 annual and OSD electricity savings are shown for the combined single-family and multi-family savings.

Using the 2007 eGRID the total NOx reductions from electricity and natural gas savings from new construction in 2009 are 151.15 tons NOx/year, which represents 55.78 tons NOx/year (36.9 %) from single-family residential electricity savings, 90.59 tons NOx/year (59.9%) from multi-family residential electricity savings, and 4.78 tons NOx/year (3.2%) from natural gas savings from single-family and multi-family residential. On a peak Ozone Season Day (OSD), the NOx reductions in 2008 are calculated to be 0.81 tons of NOx/day, which represents 0.38 tons NOx/day (46.9 %) from single-family residential electricity savings, 0.42 tons NOx/day (51.9 %) from multi-family residential electricity savings, and 0.01 tons NOx/day (1.2 %) from natural gas savings from single-family and multi-family residential.

Figure 73 through Figure 78 show the electricity and NOx reductions tabulated in Table 20 and Table 21. Figure 73 shows the annual electricity savings by county as a stacked bar chart, and Figure 74 shows the OSD electricity savings by county in a similar fashion. Figure 75 shows the spatial distribution of the electricity savings by county across the state.

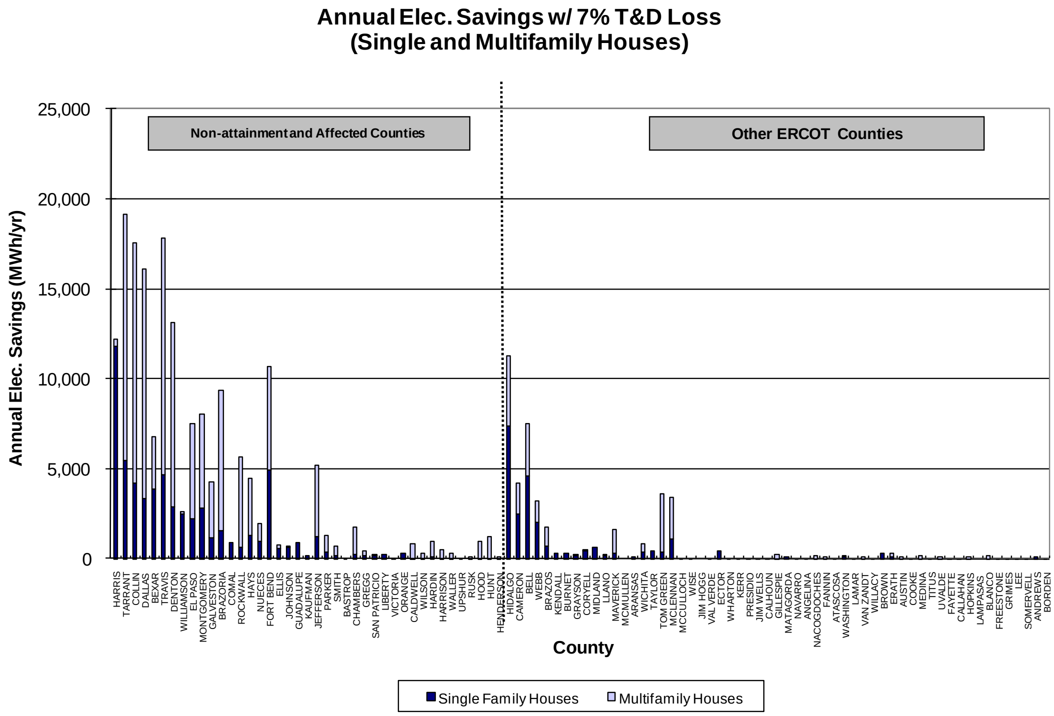
Figure 76 shows the annual NOx reductions in a similar format as the electricity savings using a stacked bar chart with the ordering of the counties determined by Table 20 and Table 21. Figure 77 shows the OSD NOx reductions, also as a stacked bar chart, and Figure 78 shows the spatial distribution of the NOx savings by county across the state.

Table 20: 2009 Annual and OSD NOx Reductions from Electricity and Natural Gas Savings Due to the IECC/IRC for Single-family and Multi-family Residences by county (Using 1999 Base year and 2007 eGRID) (1)

	Electricity Savings and Resultant NOx Reductions (Single Family Houses)				Electricity Savings and Resultant NOx Reductions (Multifamily Houses)				Total Electricity Savings and Resultant NOx Reductions (Single and Multi-Family Houses)				Total Natural Gas Savings and Resultant NOx Reductions (Single and Multi-Family Houses)				Total Nox Reductions	
County	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Total OSD N.G. Savings (Therm/County)	OSD Nox Reductions (Tons)	Annual Nox Reductions (Tons)	OSD Nox Reductions (Tons)
HARRIS	11,837.49	6.56	82.08	0.05	373.99	8.38	1.66	0.04	12,211.47	14.94	83.7321	0.0942	99,917.66	0.46	214.4799	0.0010	15.40	0.0952
TARRANT	5,468.22	2.08	42.57	0.02	13,648.50	4.51	67.51	0.03	19,116.72	6.60	110.0724	0.0475	97,055.65	0.45	90.1216	0.0004	7.04	0.0479
COLLIN	4,183.28	0.11	32.45	0.00	13,398.32	0.21	64.58	0.00	17,581.60	0.32	97.0240	0.0017	83,665.20	0.38	68.4641	0.0003	0.71	0.0020
DALLAS	3,307.88	0.76	25.75	0.01	12,825.11	1.65	63.43	0.01	16,132.99	2.41	89.1829	0.0148	69,127.17	0.32	54.5170	0.0003	2.73	0.0151
BEXAR	3,889.57	3.68	27.93	0.02	2,907.18	2.36	14.20	0.01	6,796.75	6.04	42.1234	0.0347	44,653.33	0.21	73.1670	0.0003	6.24	0.0351
TRAVIS	4,664.05	0.08	33.30	0.00	13,144.60	0.15	65.79	0.00	17,808.64	0.23	99.0949	0.0013	50,916.32	0.23	73.8936	0.0003	0.46	0.0016
DENTON	2,848.99	0.03	22.88	0.00	10,304.94	0.05	49.67	0.00	13,153.93	0.07	72.5493	0.0005	77,868.53	0.36	49.8343	0.0002	0.43	0.0008
WILLIAMSON	2,503.37	0.00	17.87	0.00	124.16	0.00	0.62	0.00	2,627.53	0.00	18.4952	0.0000	19,108.02	0.09	39.6616	0.0002	0.09	0.0002
EL PASO	2,187.74	0.00	13.60	0.00	5,327.54	0.00	17.09	0.00	7,515.29	0.00	30.6870	0.0000	71,129.53	0.33	53.2858	0.0002	0.33	0.0002
MONTGOMERY	2,831.97	0.00	19.64	0.00	5,196.43	0.00	23.02	0.00	8,028.40	0.00	42.6596	0.0000	33,468.56	0.15	51.3116	0.0002	0.15	0.0002
GALVESTON	1,162.22	3.43	8.06	0.02	3,093.32	4.66	13.70	0.02	4,255.55	8.09	21.7601	0.0376	15,474.34	0.07	21.0946	0.0001	8.16	0.0377
BRAZORIA	1,525.16	0.89	10.57	0.01	7,826.60	1.19	34.67	0.01	9,351.76	2.08	45.2443	0.0125	27,309.17	0.13	27.6820	0.0001	2.20	0.0126
COMAL	886.29	0.00	6.36	0.00	0.00	0.00	0.00	0.00	886.29	0.00	6.3631	0.0000	9,036.03	0.04	16.6720	0.0001	0.04	0.0001
ROCKWALL	628.88	0.00	5.05	0.00	5,029.12	0.00	24.24	0.00	5,657.99	0.00	29.2899	0.0000	24,147.32	0.11	11.0003	0.0001	0.11	0.0001
HAYS	1,285.45	0.21	9.18	0.00	3,153.71	0.41	15.79	0.00	4,439.16	0.62	24.9636	0.0035	13,476.61	0.06	20.3657	0.0001	0.68	0.0036
NUECES	931.20	1.90	5.57	0.01	988.24	1.90	4.18	0.01	1,919.44	3.80	9.7506	0.0183	7,438.89	0.03	14.6737	0.0001	3.83	0.0184
FORT BEND	4,948.03	6.77	34.31	0.04	5,708.20	8.65	25.29	0.03	10,656.23	15.41	59.5988	0.0678	52,163.03	0.24	89.6519	0.0004	15.65	0.0682
ELLIS	581.73	0.56	4.53	0.00	187.95	1.22	0.93	0.01	769.67	1.78	5.4580	0.0107	7,443.44	0.03	9.5874	0.0000	1.81	0.0107
JOHNSON	630.71	0.02	4.91	0.00	35.80	0.03	0.18	0.00	666.51	0.04	5.0868	0.0003	7,687.32	0.04	10.3948	0.0000	0.08	0.0003
GUADALUPE	872.34	0.17	6.26	0.00	0.00	0.34	0.00	0.00	872.34	0.51	6.2629	0.0028	8,893.82	0.04	16.4096	0.0001	0.55	0.0029
KAUFMAN	156.93	1.08	1.26	0.01	0.00	2.35	0.00	0.01	156.93	3.43	1.2604	0.0198	2,855.17	0.01	2.7450	0.0000	3.44	0.0198
JEFFERSON	1,230.02	0.00	8.37	0.00	3,933.23	0.00	17.27	0.00	5,163.24	0.00	25.6438	0.0000	17,062.48	0.08	22.2973	0.0001	0.08	0.0001
PARKER	385.40	0.01	3.10	0.00	920.42	0.02	4.44	0.00	1,305.83	0.03	7.5316	0.0004	9,337.34	0.04	6.7415	0.0000	0.08	0.0004
SMITH	149.61	0.00	1.17	0.00	540.89	0.00	2.45	0.00	690.49	0.00	3.6244	0.0000	4,143.37	0.02	2.9606	0.0000	0.02	0.0000
BASTROP	29.47	0.38	0.21	0.00	0.00	0.76	0.00	0.00	29.47	1.14	0.2098	0.0063	203.55	0.00	0.4256	0.0000	1.14	0.0063
CHAMBERS	261.35	2.09	1.78	0.01	1,506.59	2.67	6.62	0.01	1,767.94	4.76	8.4045	0.0266	4,815.05	0.02	4.7555	0.0000	4.79	0.0267
GREGG	144.75	0.00	1.15	0.00	303.51	0.00	1.37	0.00	448.26	0.00	2.5184	0.0000	3,870.23	0.02	2.9051	0.0000	0.02	0.0000
SAN PATRICIO	186.71	0.42	1.12	0.00	40.75	0.42	0.17	0.00	227.46	0.84	1.2889	0.0045	1,286.76	0.01	2.9421	0.0000	0.85	0.0045
LIBERTY	236.62	0.00	1.64	0.00	0.00	0.00	0.00	0.00	236.62	0.00	1.6391	0.0000	1,970.51	0.01	4.2744	0.0000	0.01	0.0000
VICTORIA	40.55	0.22	0.29	0.00	0.00	0.26	0.00	0.00	40.55	0.48	0.2858	0.0023	393.75	0.00	0.8512	0.0000	0.48	0.0023
ORANGE	325.41	0.00	2.22	0.00	0.00	0.00	0.00	0.00	325.41	0.00	2.2152	0.0000	2,714.85	0.01	5.9028	0.0000	0.01	0.0000
CALDWELL	25.41	0.00	0.18	0.00	792.46	0.00	0.00	0.00	817.86	0.00	0.1816	0.0000	194.45	0.00	0.4037	0.0000	0.00	0.0000
WILSON	28.97	0.00	0.21	0.00	238.54	0.00	1.16	0.00	267.51	0.00	1.3730	0.0000	705.43	0.00	0.5450	0.0000	0.00	0.0000
HARDIN	128.53	0.00	0.87	0.00	835.33	0.00	3.67	0.00	963.86	0.00	4.5431	0.0000	2,519.96	0.01	2.3315	0.0000	0.01	0.0000
HARRISON	37.36	0.00	0.30	0.00	438.72	0.00	1.96	0.00	476.08	0.00	2.2603	0.0000	2,221.22	0.01	0.7587	0.0000	0.01	0.0000
WALLER	6.13	0.00	0.04	0.00	295.25	0.00	1.31	0.00	301.38	0.00	1.3507	0.0000	604.32	0.00	0.1110	0.0000	0.00	0.0000
UPSHUR	9.35	0.00	0.07	0.00	0.00	0.00	0.00	0.00	9.35	0.00	0.0737	0.0000	166.50	0.00	0.1480	0.0000	0.00	0.0000
RUSK	4.67	0.12	0.04	0.00	19.74	0.25	0.08	0.00	24.40	0.37	0.1149	0.0000	140.82	0.00	0.1110	0.0000	0.37	0.0000
HOOD	50.21	2.15	0.39	0.02	877.08	4.65	4.34	0.02	927.30	6.80	4.7289	0.0376	2,605.02	0.01	0.8275	0.0000	6.81	0.0376
HUNT	56.49	1.06	0.44	0.01	1,180.87	2.30	5.69	0.01	1,237.36	3.36	6.1287	0.0194	3,668.49	0.02	0.9285	0.0000	3.37	0.0194
HENDERSON	45.40	0.14	0.36	0.00	22.08	0.30	0.10	0.00	67.47	0.44	0.4608	0.0029	967.84	0.00	0.9252	0.0000	0.45	0.0029
HIDALGO	7,362.60	1.57	40.07	0.01	3,935.28	1.57	17.18	0.01	11,297.88	3.15	57.2505	0.0196	12,671.76	0.06	51.6817	0.0002	3.21	0.0199
CAMERON	2,475.29	0.40	13.47	0.00	1,756.07	0.40	7.66	0.00	4,231.36	0.81	21.1375	0.0045	4,736.63	0.02	17.3753	0.0001	0.83	0.0046
BELL	4,613.04		31.98		2,883.08		13.53		7,496.13	0.00	45.5126	0.0000	29,521.30	0.14	37.1587	0.0002	0.14	0.0002
WEBB	1,994.12	0.17	10.43	0.00	1,202.19	0.17	5.09	0.00	3,196.31	0.33	15.5202	0.0012	5,039.23	0.02	13.4829	0.0001	0.36	0.0012
BRAZOS	722.03	0.10	5.01	0.00	1,043.22	0.19	4.62	0.00	1,765.26	0.29	9.6285	0.0016	8,005.61	0.04	13.0823	0.0001	0.33	0.0017
KENDALL	307.01		2.02		0.00		0.00		307.01	0.00	2.0155	0.0000	1,856.66	0.01	2.9872	0.0000	0.01	0.0000
BURNET	299.39		2.14		0.00		0.00		299.39	0.00	2.1376	0.0000	2,267.57	0.01	4.7432	0.0000	0.01	0.0000
GRAYSON	132.63		1.03		47.23		0.23		179.86	0.00	1.2570	0.0000	1,706.65	0.01	2.1799	0.0000	0.01	0.0000
CORYELL	415.95		2.88		113.06		0.53		529.01	0.00	3.4142	0.0000	2,319.51	0.01	3.3505	0.0000	0.01	0.0000
MIDLAND	638.15		3.60		0.00		0.00		638.15	0.00	3.6046	0.0000	10,759.71	0.05	6.6607	0.0000	0.05	0.0000
LLANO	173.26	0.10	1.24	0.00	16.55	0.21	0.08	0.00	189.82	0.31	1.3199	0.0018	1,331.93	0.01	2.7450	0.0000	0.32	0.0018
MAVERICK	301.51		1.58		1,324.45		5.61		1,625.95	0.00	7.1824	0.0000	2,248.58	0.01	2.0386	0.0000	0.01	0.0000
MCMULLEN	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
ARANSAS	113.90		0.68		0.00		0.00		113.90	0.00	0.6811	0.0000	752.66	0.00	1.7949	0.0000	0.00	0.0000
WICHITA	395.19	0.04	2.55	0.00	417.33	0.08	1.58	0.00	812.53	0.11	4.1300	0.0007	11,080.38	0.05	3.2496	0.0000	0.16	0.0007
TAYLOR	443.35	0.00	2.73	0.00	0.00	0.00	0.00	0.00	443.35	0.00	2.7286	0.0000	7,521.84	0.03	4.0570	0.0000	0.03	0.0000
TOM GREEN	389.59	0.01	2.36	0.00	3,186.79	0.01	11.58	0.00	3,576.39	0.02	13.9354	0.0000	12,134.49	0.06	3.6533	0.0000	0.08	0.0000
MCLENNAN	1,062.43	4.20	7.36	0.03	2,355.46	9.11	11.06	0.04	3,417.89	13.31	18.4222	0.0703	10,741.26	0.05	8.5580	0.0000	13.36	0.0703
MCCULLOCH	2.15		0.01		0.00		0.00		2.15	0.00	0.0130	0.0000	15.07	0.00	0.0202	0.0000	0.00	0.0000
WISE	39.46	0.49	0.31	0.00	0.00	1.05	0.00	0.01	39.46	1.54	0.3061	0.0089	469.96	0.00	0.6459	0.0000	1.54	0.0089
JIM HOGG	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
VAL VERDE	47.21		0.34		0.00		0.00		47.21	0.00	0.3390	0.0000	481.34	0.00	0.8881	0.0000	0.00	0.0000
ECTOR	425.44	0.61	2.40	0.00	0.00	1.31	0.00	0.01	425.44	1.92	2.4031	0.0111	7,173.14	0.03	4.4405	0.0000	1.95	0.0111
WHARTON	61.70	0.01	0.43	0.00	0.00	0.02	0.00	0.00	61.70	0.03	0.4349	0.0002	599.19	0.00	1.2953	0.0000	0.03	0.0002
KERR	58.60		0.42		0.00		0.00		58.60	0.00	0.4184	0.0000	443.86	0.00	0.9285	0.0000	0.00	0.0000
PRESIDIO	10.76	0.00	0.07	0.00	0.00	0.00	0.00	0.00	10.76	0.00	0.0652	0.0000	75.33	0.00	0.1009	0.0000	0.00	0.0000
JIM WELLS	12.92		0.08		0.00		0.00		12.92	0.00	0.0772	0.0000	85.35	0.00	0.2035	0.0000	0.00	0.0000
CALHOUN	52.89	0.69	0.37	0.00	0.00	0.69	0.00	0.00	52.89	1.38	0.3728	0.0072	513.59	0.00	1.1102	0.0000	1.38	0.0072
GILLESPIE	35.67		0.25		206.94		1.04		242.61	0.00	1.2905	0.0000	515.62	0.00	0.5652	0.0000	0.00	0.0000
MATAGORDA	69.63		0.49		0.00		0.00		69.63	0.00	0.4908	0.0000	676.23	0.00	1.4618	0.0000	0.00	0.0000
NAVARRO	52.62		0.36		0.00		0.00		52.62	0.00	0.3648	0.0000	260.10	0.00	0.4239	0.0000	0.00	0.0000
ANGELINA	40.44	0.05	0.31	0.00	0.00	0.12	0.00	0.00	40.44	0.17	0.3111	0.0010	602.91	0.00	0.9622	0.0000	0.17	0.0010
NACOGDOCHES	31.11		0.24		118.41		0.47		149.52	0.00	0.7131	0.0000	891.28	0.00	0.7402	0.0000	0.00	0.0000
FANNIN	13.51	1.21	0.10	0.01	56.68	2.62	0.27	0.01	70.19	3.83	0.3780	0.0233	305.28	0.00	0.2220	0.0000	3.83	0.0233
ATASCOSA	63.94		0.42		0.00		0.00		63.94	0.00	0.4215	0.0000	58.62	0.00	0.6459	0.0000	0.00	0.0000
WASHINGTON	83.74		0.58		39.37		0.17		123.11	0.00	0.7551	0.0000	775.64	0.00	1.5173	0.0000	0.00	0.0000
LAMAR	48.64	0.16	0.36	0.00	0.00	0.35	0.00	0.00	48.64	0.52	0.3638	0.0033	661.24	0.00	0.4996	0.0000	0.52	0.0033
VAN ZANDT	16.03		0.12		94.89		0.46		110.92	0.00	0.5817	0.0000	430.65	0.00	0.2624	0.0000	0.00	0.0000
WILLACY	65.90		0.36		0.00		0.00		65.90	0.00	0.3587	0.0000	74.67	0.00	0.4626	0.0000	0.00	0.0000
BROWN	270.62		1.88		0.00		0.00		270.62	0.00	1.8760	0.0000	1,337.64	0.01	2.1799	0.0000	0.01	0.0000
ERATH	68.38		0.42		229.44		0.83		297.82	0.00	1.2508	0.0000	1,904.37	0.01	0.6257	0.0000	0.01	0.0000
AUSTIN	30.64		0.21		39.37		0.17		70.00	0.00	0.3869	0.0000	330.52	0.00	0.5551	0.0000	0.00	0.0000
COOKE	34.39		0.27		0.00		0.00		34.39	0.00	0.2669	0.0000	411.43	0.00	0.5652	0.0000	0.00	0.0000
MEDINA	15.02		0.11		119.27		0.58		134.29	0.00	0.6903	0.0000	358.18	0.00	0.2826	0.0000	0.00	0.0000
TITUS	18.02	0.98	0.13	0.00	0.00	2.11	0.00	0.00	18.02	3.09	0.1347	0.0000	244.90	0.00	0.1850	0.0000	3.09	0.0000
UVALDE	20.39		0.15		67.09		0.33		87.48	0.00	0.4740	0.0000	323.18	0.00	0.3835	0.0000	0.00	0.0000
FAYETTE	5.11	0.00	0.04	0.00	0.00	0.00	0.00	0.00	5.11	0.00	0.0354	0.0000	42.80	0.00	0.0925	0.0000	0.00	0.0000
CALLAHAN	26.47		0.16		0.00		0.00		26.47	0.00	0.1629	0.0000	449.07	0.00	0.2422	0.0000	0.00	0.0000
HOPKINS	9.87		0.08		56.93		0.27		66.80	0.00	0.3509	0.0000	261.33	0.00	0.1615	0.0000	0.00	0.0000
LAMPASAS	37.59		0.26		0.00		0.00		37.59	0.00	0.2606	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
BLANCO	8.92		0.06		132.44		0.66		141.36	0.00	0.7266	0.0000	224.63	0.00	0.1413	0.0000	0.00	0.0000
FREESTONE	12.53	0.63	0.09	0.00	0.00	1.36	0.00	0.01	12.53	1.99	0.0869	0.0115	61.93	0.00	0.1009	0.0000	1.99	0.0115
GRIMES	15.32	0.00	0.11	0.00	0.00	0.00	0.00	0.00	15.32	0.00	0.1062	0.0005	128.40	0.00	0.2776	0.0000	0.00	0.0005
LEE	8.89		0.06		0.00		0.00		8.89	0.00	0.0636	0.0000	68.06	0.00	0.1413	0.0000	0.00	0.0000
SOMERVELL	35.52		0.28		0.00		0.00		35.52	0.00	0.2765	0.0000	428.28	0.00	0.5853	0.0000	0.00	0.0000
ANDREWS	88.95	0.00	0.50	0.00	0.00	0.01	0.00	0.00	88.95	0.01	0.5025	0.0001	1,499.84	0.01	0.9285	0.0000	0.02	0.0001
BORDEN	33.31		0.17		0.00		0.00		33.31	0.00	0.1707	0.0000	1,204.82	0.01	0.3516	0.0000	0.01	0.0000

Table 21: 2009 Annual and OSD NOx Reductions from Electricity and Natural Gas Savings Due to the IECC/IRC for Single-family and Multi-family Residences by County (Using 1999 Base year and 2007 eGRID) (2)

	Electricity Savings and Resultant NOx Reductions (Single Family Houses)				Electricity Savings and Resultant NOx Reductions (Multifamily Houses)				Total Electricity Savings and Resultant NOx Reductions (Single and Multi-Family Houses)				Total Natural Gas Savings and Resultant NOx Reductions (Single and Multi-Family Houses)				Total Nox Reductions	
County	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Total OSD N.G. Savings (Therm/County)	OSD Nox Reductions (Tons)	Annual Nox Reductions (Tons)	OSD Nox Reductions (Tons)
CHEROKEE	7.78	0.60	0.06	0.00	98.68	1.30	0.39	0.01	106.45	1.90	0.4546	0.0107	472.20	0.00	0.1850	0.0000	1.90	0.0107
DIMMIT	20.90		0.11		0.00		0.00		20.90	0.00	0.1093	0.0000	36.42	0.00	0.1413	0.0000	0.00	0.0000
FALLS	10.02		0.07		0.00		0.00		10.02	0.00	0.0695	0.0000	49.54	0.00	0.0807	0.0000	0.00	0.0000
COLORADO	12.26		0.08		0.00		0.00		12.26	0.00	0.0850	0.0000	102.72	0.00	0.2220	0.0000	0.00	0.0000
FRIO	23.98	0.09	0.16	0.00	0.00	0.10	0.00	0.00	23.98	0.19	0.1581	0.0016	21.98	0.00	0.2422	0.0000	0.19	0.0016
MILAM	5.09	0.38	0.03	0.00	19.68	0.83	0.09	0.00	24.77	1.22	0.1189	0.0050	37.45	0.00	0.0404	0.0000	1.22	0.0050
JACKSON	6.17		0.04		0.00		0.00		6.17	0.00	0.0435	0.0000	59.92	0.00	0.1295	0.0000	0.00	0.0000
ANDERSON	10.11		0.08		0.00		0.00		10.11	0.00	0.0778	0.0000	150.73	0.00	0.2406	0.0000	0.00	0.0000
HILL	35.08		0.24		0.00		0.00		35.08	0.00	0.2432	0.0000	173.40	0.00	0.2826	0.0000	0.00	0.0000
CULBERSON	16.84		0.09		0.00		0.00		16.84	0.00	0.0920	0.0000	191.63	0.00	0.1817	0.0000	0.00	0.0000
MASON	3.82		0.03		0.00		0.00		3.82	0.00	0.0273	0.0000	28.95	0.00	0.0606	0.0000	0.00	0.0000
PECOS	12.91	0.01	0.08	0.00	0.00	0.02	0.00	0.00	12.91	0.02	0.0782	0.0001	90.40	0.00	0.1211	0.0000	0.02	0.0001
RAINS	3.70		0.03		0.00		0.00		3.70	0.00	0.0287	0.0000	44.06	0.00	0.0606	0.0000	0.00	0.0000
LAVACA	10.70		0.07		0.00		0.00		10.70	0.00	0.0728	0.0000	56.43	0.00	0.1110	0.0000	0.00	0.0000
PALO PINTO	13.23	0.17	0.08	0.00	0.00	0.31	0.00	0.00	13.23	0.48	0.0814	0.0026	224.53	0.00	0.1211	0.0000	0.48	0.0026
KIMBLE	2.15		0.01		0.00		0.00		2.15	0.00	0.0130	0.0000	15.07	0.00	0.0202	0.0000	0.00	0.0000
MADISON	12.26		0.08		0.00		0.00		12.26	0.00	0.0850	0.0000	102.72	0.00	0.2220	0.0000	0.00	0.0000
ARCHER	22.09		0.14		0.00		0.00		22.09	0.00	0.1425	0.0000	534.54	0.00	0.1817	0.0000	0.00	0.0000
REFUGIO	7.05		0.05		0.00		0.00		7.05	0.00	0.0497	0.0000	68.48	0.00	0.1480	0.0000	0.00	0.0000
LIMESTONE	5.01	0.07	0.03	0.00	18.84	0.09	0.09	0.00	23.86	0.16	0.1232	0.0000	68.69	0.00	0.0404	0.0000	0.16	0.0000
CLAY	4.91		0.03		0.00		0.00		4.91	0.00	0.0317	0.0000	118.79	0.00	0.0404	0.0000	0.00	0.0000
BEE	3.53		0.02		0.00		0.00		3.53	0.00	0.0249	0.0000	34.24	0.00	0.0740	0.0000	0.00	0.0000
MARTIN	1.93		0.01		0.00		0.00		1.93	0.00	0.0109	0.0000	32.61	0.00	0.0202	0.0000	0.00	0.0000
GONZALES	1.07		0.01		0.00		0.00		1.07	0.00	0.0077	0.0000	10.94	0.00	0.0202	0.0000	0.00	0.0000
BURLESON	12.26		0.08		0.00		0.00		12.26	0.00	0.0850	0.0000	102.72	0.00	0.2220	0.0000	0.00	0.0000
KARNES	112.67		0.73		0.00		0.00		112.67	0.00	0.7278	0.0000	143.31	0.00	1.0294	0.0000	0.00	0.0000
KLEBERG	72.32		0.40		0.00		0.00		72.32	0.00	0.4018	0.0000	88.70	0.00	0.5551	0.0000	0.00	0.0000
BREWSTER	43.05		0.26		0.00		0.00		43.05	0.00	0.2607	0.0000	301.32	0.00	0.4037	0.0000	0.00	0.0000
WINKLER	1.93		0.01		0.00		0.00		1.93	0.00	0.0109	0.0000	32.61	0.00	0.0202	0.0000	0.00	0.0000
FRANKLIN	2.47		0.02		0.00		0.00		2.47	0.00	0.0191	0.0000	29.37	0.00	0.0404	0.0000	0.00	0.0000
YOUNG	11.03	1.07	0.07	0.01	0.00	2.31	0.00	0.01	11.03	3.38	0.0679	0.0168	187.11	0.00	0.1009	0.0000	3.38	0.0168
HOUSTON	2.33		0.02		0.00		0.00		2.33	0.00	0.0179	0.0000	34.78	0.00	0.0555	0.0000	0.00	0.0000
SCURRY	5.26		0.03		0.00		0.00		5.26	0.00	0.0269	0.0000	190.23	0.00	0.0555	0.0000	0.00	0.0000
BOSQUE	10.02	0.03	0.07	0.00	0.00	0.06	0.00	0.00	10.02	0.09	0.0695	0.0008	49.54	0.00	0.0807	0.0000	0.09	0.0008
COMANCHE	7.52		0.05		0.00		0.00		7.52	0.00	0.0521	0.0000	37.16	0.00	0.0606	0.0000	0.00	0.0000
BRISCOE	11.17		0.04		0.00		0.00		11.17	0.00	0.0432	0.0000	1,053.52	0.00	0.1413	0.0000	0.00	0.0000
CONCHO	2.15		0.01		0.00		0.00		2.15	0.00	0.0130	0.0000	15.07	0.00	0.0202	0.0000	0.00	0.0000
ZAVALA	23.88		0.12		0.00		0.00		23.88	0.00	0.1249	0.0000	41.62	0.00	0.1615	0.0000	0.00	0.0000
NOLAN	2.21	0.10	0.01	0.00	0.00	0.21	0.00	0.00	2.21	0.31	0.0136	0.0018	37.42	0.00	0.0202	0.0000	0.31	0.0018
BROOKS	10.54		0.06		0.00		0.00		10.54	0.00	0.0574	0.0000	11.95	0.00	0.0740	0.0000	0.00	0.0000
ROBERTSON	8.17	0.13	0.06	0.00	29.53	0.26	0.13	0.00	37.70	0.40	0.1875	0.0011	123.77	0.00	0.1480	0.0000	0.40	0.0011
LIVE OAK	9.39		0.06		0.00		0.00		9.39	0.00	0.0562	0.0000	62.07	0.00	0.1480	0.0000	0.00	0.0000
HAMILTON	7.52		0.05		0.00		0.00		7.52	0.00	0.0521	0.0000	37.16	0.00	0.0606	0.0000	0.00	0.0000
JONES	2.21	0.34	0.01	0.00	0.00	0.34	0.00	0.00	2.21	0.68	0.0136	0.0035	37.42	0.00	0.0202	0.0000	0.68	0.0035
REAGAN	5.97		0.03		0.00		0.00		5.97	0.00	0.0349	0.0000	22.71	0.00	0.0606	0.0000	0.00	0.0000
WARD	13.54	3.18	0.08	0.02	0.00	6.89	0.00	0.04	13.54	10.07	0.0765	0.0604	228.24	0.00	0.1413	0.0000	10.07	0.0604
RED RIVER	12.61	0.00	0.09	0.00	0.00	0.00	0.00	0.00	12.61	0.00	0.0943	0.0000	171.43	0.00	0.1295	0.0000	0.00	0.0000
HASKELL	2.21	0.00	0.01	0.00	31.29	0.00	0.11	0.00	33.49	0.00	0.1268	0.0000	138.91	0.00	0.0202	0.0000	0.00	0.0000
HOWARD	3.87	0.10	0.02	0.00	0.00	0.21	0.00	0.00	3.87	0.30	0.0218	0.0018	65.21	0.00	0.0404	0.0000	0.30	0.0018
SAN SABA	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
JACK	22.06	0.36	0.14	0.00	0.00	0.79	0.00	0.00	22.06	1.15	0.1357	0.0066	374.22	0.00	0.2018	0.0000	1.15	0.0066
STEPHENS	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
RUNNELS	4.30		0.03		0.00		0.00		4.30	0.00	0.0261	0.0000	30.13	0.00	0.0404	0.0000	0.00	0.0000
REEVES	1.93		0.01		0.00		0.00		1.93	0.00	0.0109	0.0000	32.61	0.00	0.0202	0.0000	0.00	0.0000
DE WITT	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
CHILDRESS	10.52		0.05		0.00		0.00		10.52	0.00	0.0539	0.0000	380.47	0.00	0.1110	0.0000	0.00	0.0000
CROSBY	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
DAWSON	10.52		0.05		0.00		0.00		10.52	0.00	0.0539	0.0000	380.47	0.00	0.1110	0.0000	0.00	0.0000
MITCHELL	2.21	2.56	0.01	0.02	0.00	5.55	0.00	0.03	2.21	8.11	0.0136	0.0518	37.42	0.00	0.0202	0.0000	8.11	0.0518
WILBARGER	2.45	0.24	0.02	0.00	0.00	0.24	0.00	0.00	2.45	0.48	0.0158	0.0000	59.39	0.00	0.0202	0.0000	0.48	0.0000
COLEMAN	2.25	0.01	0.01	0.00	0.00	0.01	0.00	0.00	2.25	0.02	0.0141	0.0001	14.96	0.00	0.0202	0.0000	0.02	0.0001
UPTON	1.99	0.01	0.01	0.00	0.00	0.01	0.00	0.00	1.99	0.02	0.0116	0.0001	7.57	0.00	0.0202	0.0000	0.02	0.0001
COKE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
CROCKETT	40.90	0.00	0.25	0.00	0.00	0.00	0.00	0.00	40.90	0.00	0.2477	0.0000	286.26	0.00	0.3835	0.0000	0.00	0.0000
HARDEMAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
BANDERA	2.07		0.01		0.00		0.00		2.07	0.00	0.0136	0.0000	12.54	0.00	0.0202	0.0000	0.00	0.0000
BAYLOR	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
COTTLE	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
CRANE	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
DELTA	7.40		0.06		0.00		0.00		7.40	0.00	0.0574	0.0000	88.12	0.00	0.1211	0.0000	0.00	0.0000
DICKENS	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
DUVAL	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
EASTLAND	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
EDWARDS	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
FISHER	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
FOARD	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
GLASSCOCK	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
GOLIAD	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
HALL	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
HUDSPETH	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
IRION	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
JEFF DAVIS	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
KENEDY	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
KENT	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
KING	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
KINNEY	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
KNOX	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
LA SALLE	17.91		0.09		0.00		0.00		17.91	0.00	0.0937	0.0000	31.21	0.00	0.1211	0.0000	0.00	0.0000
LEON	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
LOVING	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
MENARD	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
MILLS	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
MONTAGUE	1.23		0.01		0.00		0.00		1.23	0.00	0.0095	0.0000	14.69	0.00	0.0202	0.0000	0.00	0.0000
MOTLEY	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
REAL	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
SCHLEICHER	4.30		0.03		0.00		0.00		4.30	0.00	0.0261	0.0000	30.13	0.00	0.0404	0.0000	0.00	0.0000
SHACKELFORD	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
STARR	5.27		0.03		0.00		0.00		5.27	0.00	0.0287	0.0000	5.97	0.00	0.0370	0.0000	0.00	0.0000
STERLING	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
STONEWALL	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
SUTTON	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
TERRELL	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
THROCKMORTON	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
ZAPATA	0.00		0.00		0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.00	0.0000	0.0000	0.00	0.0000
TOTAL	**85,311.81**	**55.78**	**587.09**	**0.38**	**134,858.75**	**90.59**	**622.00**	**0.42**	**220,170.56**	**146.37**	**1,209.09**	**0.80**	**1,039,267.15**	**4.78**	**1,282.26**	**0.01**	**151.15**	**0.81**



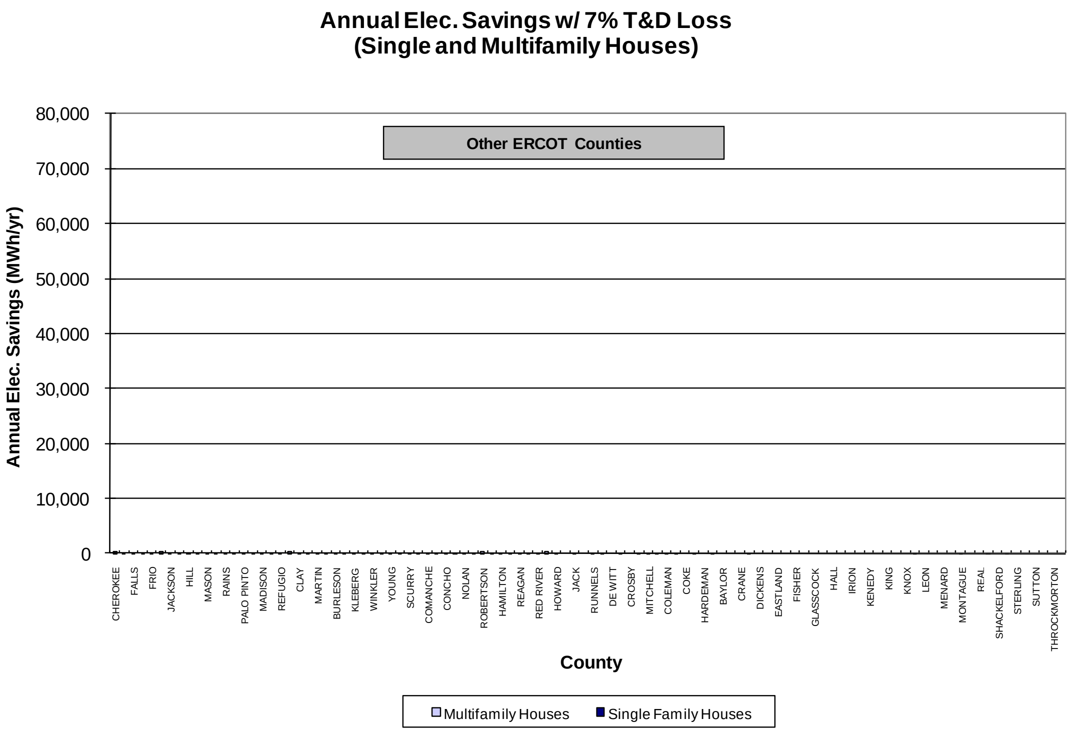
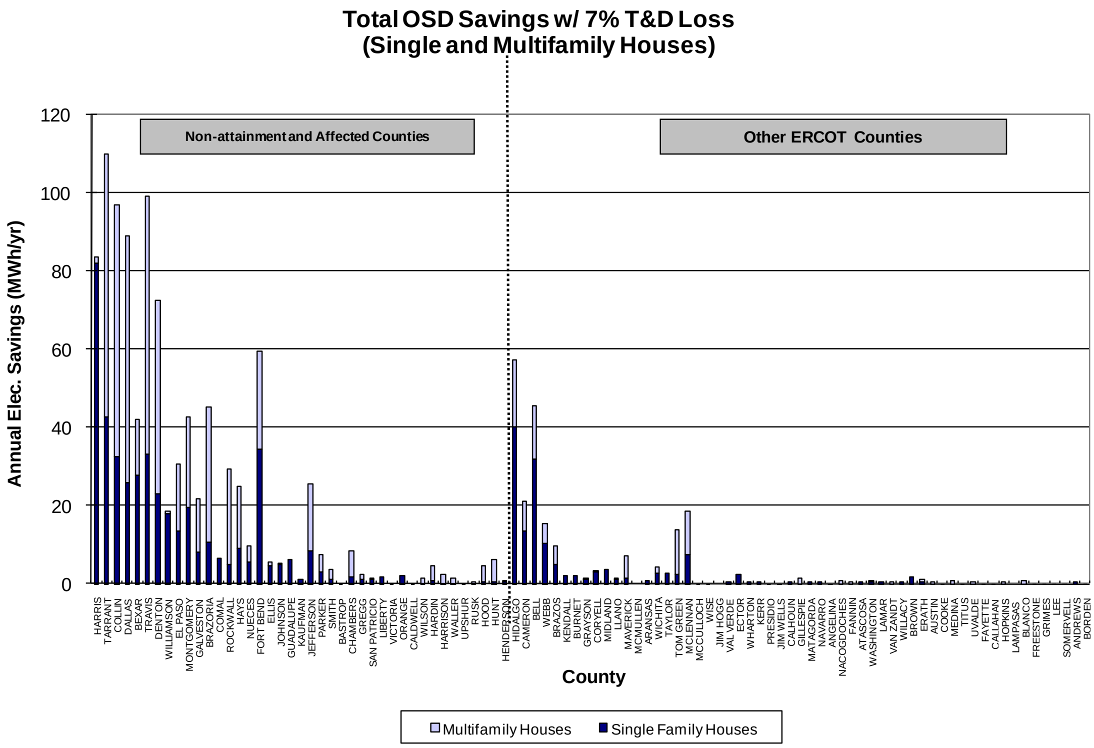


Figure 73: 2008 Annual Electricity Reductions from IECC/IRC by PCA for Single-family and Multi-family Residences by County



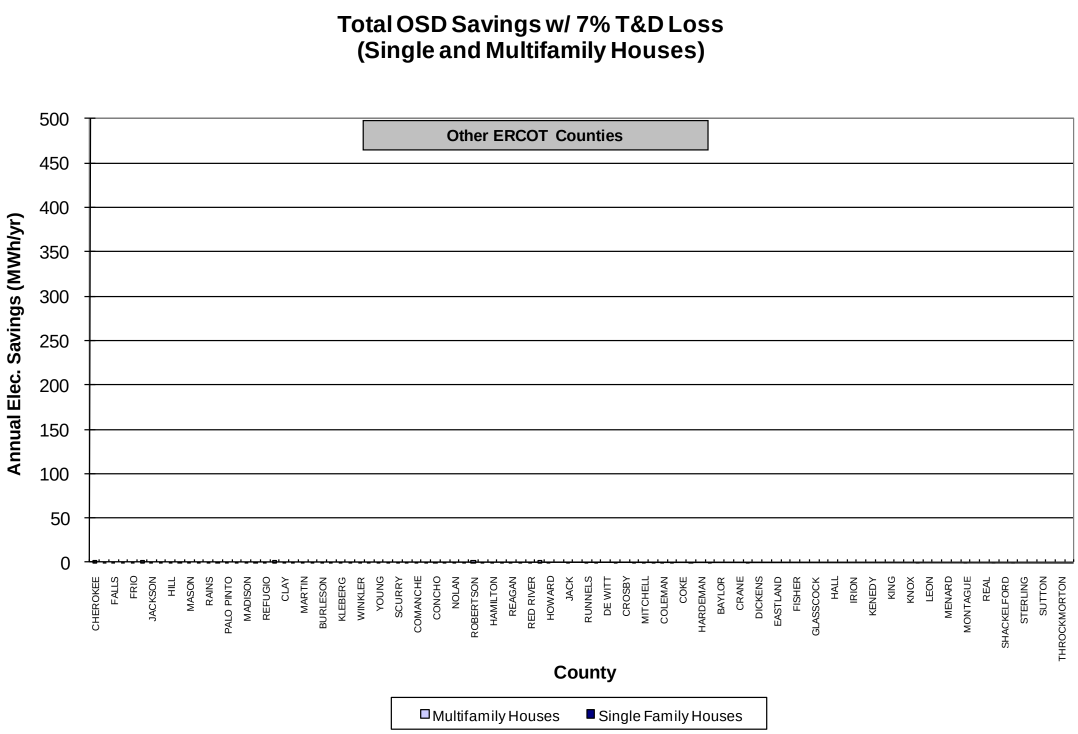


Figure 74: 2009 OSD Electricity Reductions from IECC/IRC by PCA for Single-family and Multi-family Residences by County

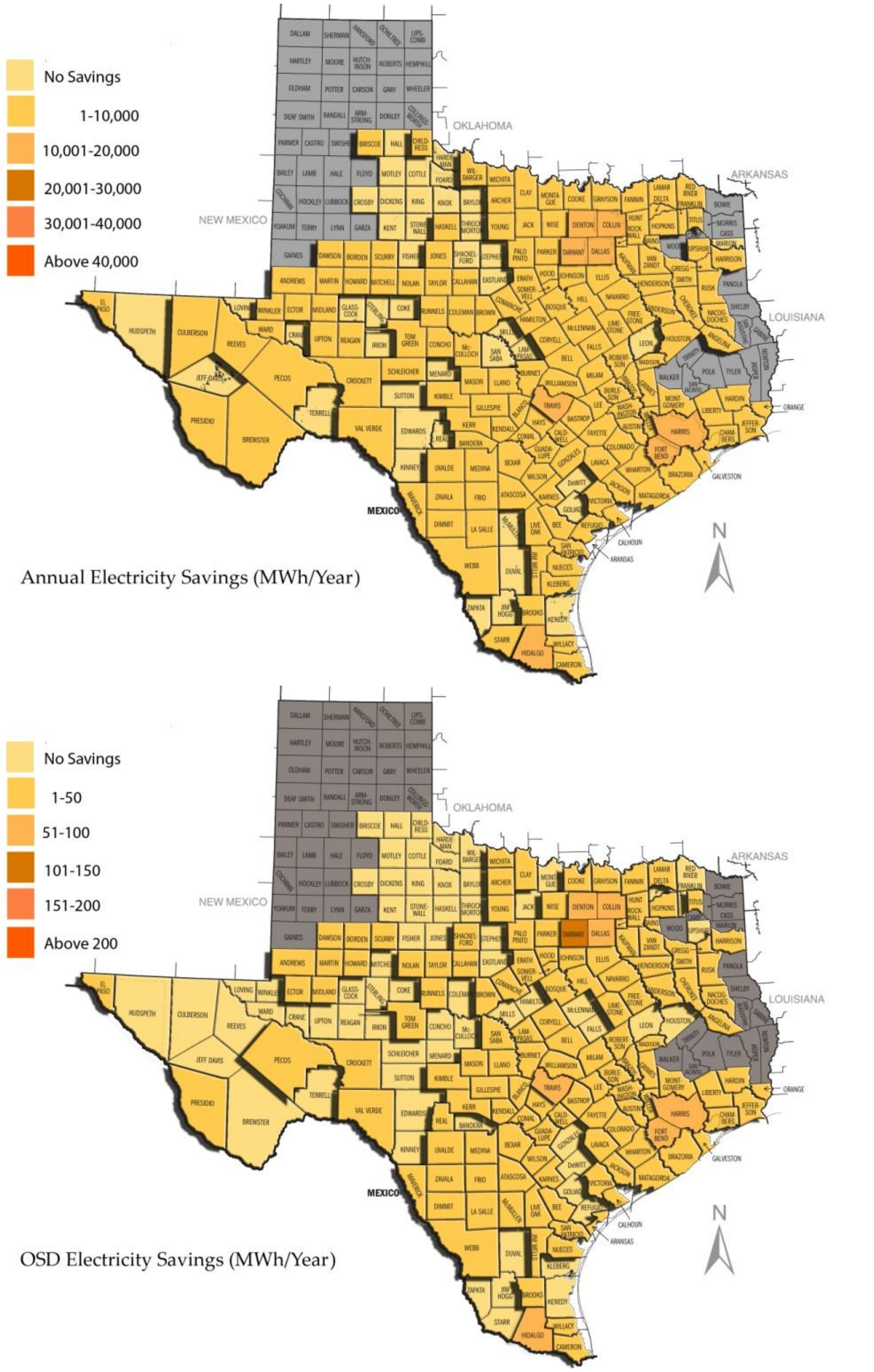
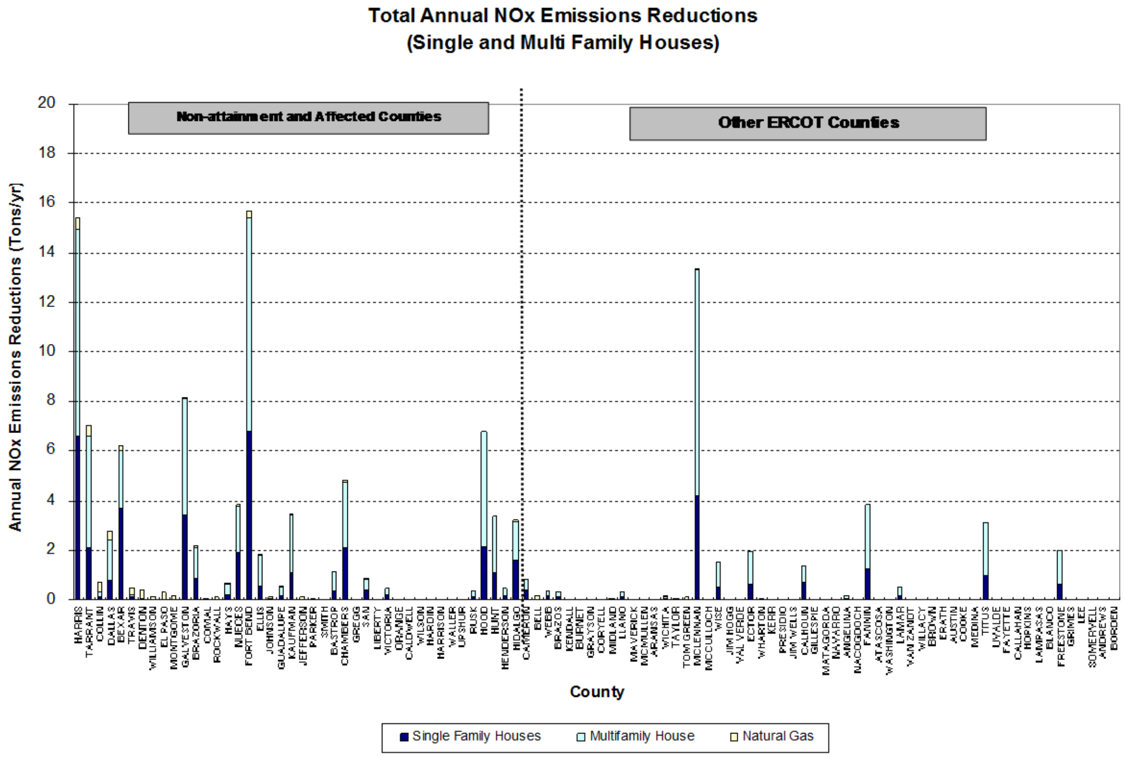


Figure 75: 2009 Annual and OSD Electricity Reductions from IECC/IRC by PCA for Single-family and Multi-family Residences by County



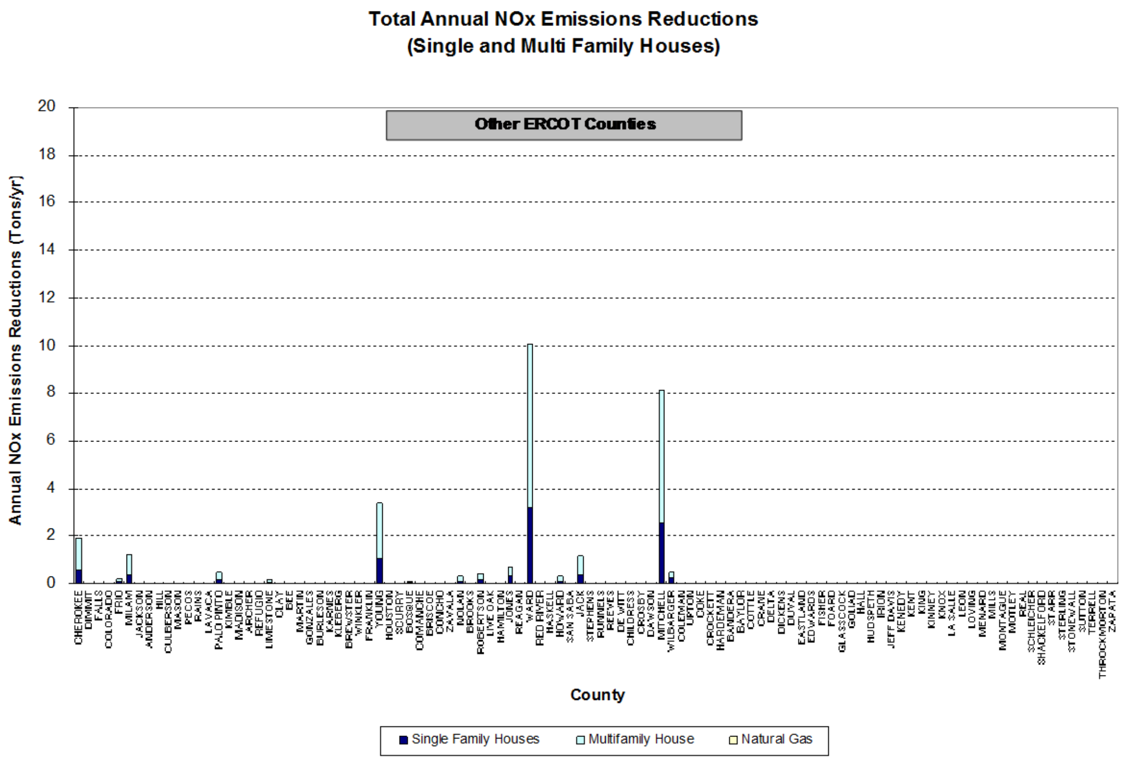
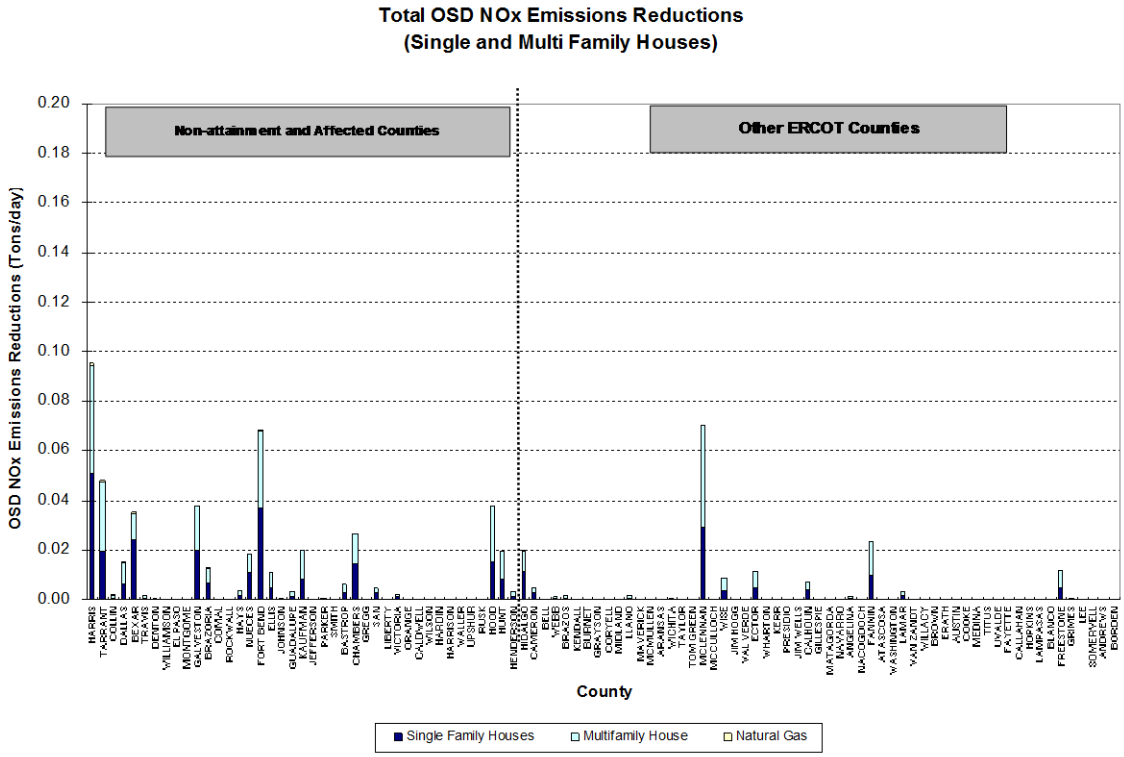


Figure 76: 2009 Annual NOx Reductions from Electricity and Natural Gas Savings due to the IECC/IRC for Single-family and Multi-family Residences by County (using 1999 Base Year and 2007 eGRID)



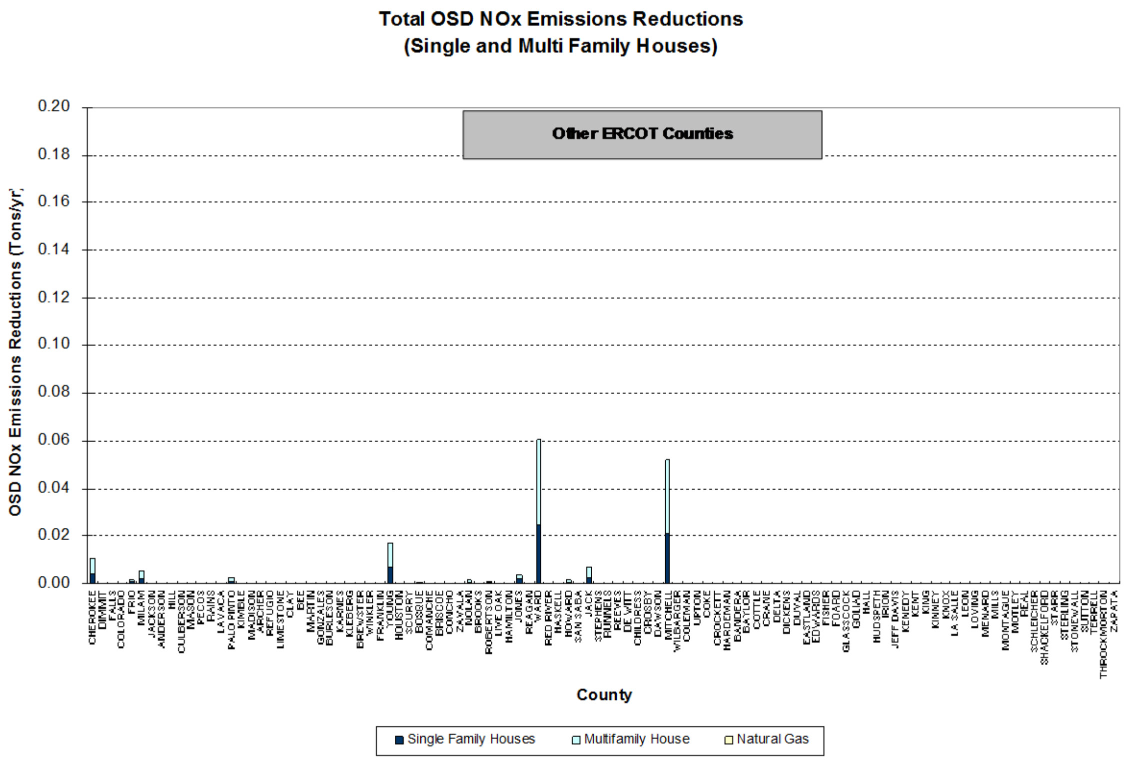


Figure 77: 2009 OSD NOx Reductions from Electricity and Natural Gas Savings due to the IECC/IRC for Single-family and Multi-family Residences by County (using 1999 Base Year and 2007 eGRID)

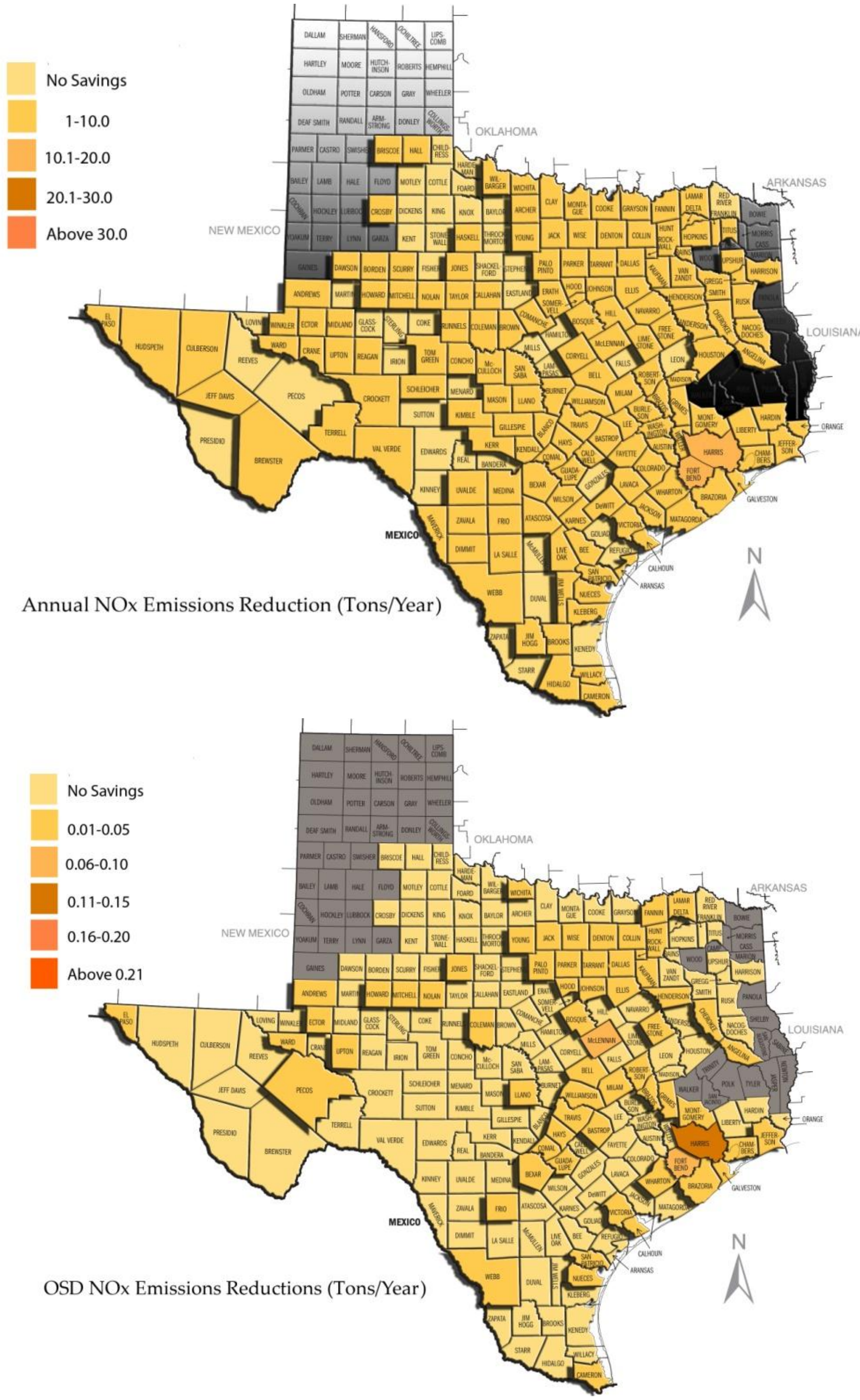


Figure 78: 2009 Annual and OSD NOx Reductions from Electricity and Natural Gas Savings Due to the IECC/IRC for Single-family and Multi-family Residences by County (Using 1999 Base Year and 2007 eGRID)

6.1.4 2009 Results for Commercial Construction

This section reports on the calculated energy and emissions savings from new commercial construction in 2009 that was built to meet the new ASHRAE Standard 90.1-1999 energy code. Construction prior to September 2001 was assumed to comply with ASHRAE Standard 90.1-1989, which was determined from a survey of engineers and architects reported in the Laboratory's 2006 Annual report to the TCEQ. To determine the energy and emissions savings from new commercial construction in all counties in ERCOT region as well as the 41 non-attainment and affected counties, data from two sources were merged into one analysis as shown in Figure 79. In this figure, the analysis covers results shown in Figure 80 to Figure 83 and in Table 24 to Table 37.

Beginning in the upper left of Figure 79, the Dodge database of the square footage of new commercial construction in Texas (Dodge 2005) was merged with the energy savings calculations published by the Pacific Northwest National Laboratory (PNNL) in a report prepared for the U.S.D.O.E. (USDOE 2004). This allowed for the new construction to be tracked by county, and energy savings to be calculated by building type. In the next block in Figure 79 and Table 22, the merged categories from the Dodge and PNNL database can be seen. This resulted in 12 Dodge categories being merged into 7 PNNL energy use categories. In the 4th and 5th PNNL category, the Dodge "stores and restaurant" category had to be split into two categories to match the two PNNL categories for "retail" and "food." To accomplish this, information published in the 1999 and 2003 CBEC database (Table 23) by the U.S.D.O.E's Energy Information Agency (EIA) was used to determine the percentages used to split the Dodge conditioned area for each county as shown (i.e., 21.06% for food and 78.94% for retail). Table 24 and Table 25 show the Dodge data for 1999 to 2005 prior to merging into the PNNL categories, which are shown by category in Figure 80 to Figure 83. Table 26 to Table 28 shows the Dodge data for 1999 to 2005 after merging into the required PNNL categories for the energy savings calculations, which were then used with the Dodge data from Table 24 and Table 25 for 2005 in the 2009 calculations. The square footage of all PNNL building types are shown for each county, followed by individual graphs of each building type in the lower seven graphs.

In the next step the PNNL energy savings, which represent buildings built to ASHRAE Standard 90.1-1989 versus Standard 90.1-1999, which are expressed per square foot, were then multiplied by the published square feet of new construction. For the 2009 results, the values for 2005 were assumed[29] for 2008. Table 29 to Table 37 shows the annual and OSD energy use calculated for new construction, by building type, for Standard 90.1-1989, and 90.1-1999. Table 38 to Table 45 shows the county-wide annual electricity and natural gas savings by building type[30] [31].

In order to calculate the Ozone Season Day electricity and natural gas savings, simulations were performed on a typical office building that simulated a 6-story, 90,000-sq. ft. office building in Central Texas. Figure 84 provides an image of the office building (3-story shown). Table 46 (building LOADS) and Table 47 (building SYSTEM and PLANT information) provide the input characteristics used to simulate the office building. The results of these simulations show about a 13% annual energy use reduction (Haberl et al. 2005). The simulations were also used to simulate the electricity and natural gas used during the Ozone Season Day (July 15 to Sept. 15) as shown in Figure 86, Figure 87, and Table 48. In the bottom row of Table 48, a ratio was calculated to allow for the conversion of annual savings to OSD savings. This ratio was then used in the remaining building types to accomplish this conversion.

In the next calculation step, electric utility providers were assigned to each county according to the published 1998 sales data from the Texas Public Utilities Commission as shown in Table 49. In the case where more than one utility was shown selling electricity in a county, a percentage of electricity use was

[29] This assumption is based on conversations with Texas State demographer's office.
[30] In this table (-) values are savings, (+) values are increased energy use.
[31] In a similar fashion as the preceeding table, in this table (-) values are savings, (+) values are increased energy use.

allocated according to the PUCT's 1998 sales data. In the lower half of Table 50, the total electricity savings by utility provider is shown for 2009 for all estimated new commercial construction. Table 50 shows the calculated annual NOx emissions reductions from electricity using the 2007 eGRID table for Texas.

In a similar fashion as the annual calculations, electric utility providers were assigned to each county to calculate the OSD electricity savings by utility, as shown in Table 51. Table 52 shows the calculated NOx emissions reductions from electricity savings using the 2007 eGRID table for Texas.

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs/year)	Lower Colorado River Auhotrity /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/PCA	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.00957217	0.27816581	0.011806715	0.012157533	0.007069474	0	0.004263638	0.020992488	0.0710018	5.259801803	0.016140391	0.680229075	0.006781035	0	0.0051797	0	0.126288	0.311448413	0.008772	1.732173298	8.294968416	0.004147484
	Chambers	0.0218814	0.63587006	0.027103415	0.027908751	0.016160386	0	0.009125896	0.044932349	0.1658435	12.28566246	0.037677498	1.587900212	0.01513807	0	0.0096055	0	0.011582	0.028562413	0.015905	3.140864708	17.75170095	0.00887585
	Fort Bend	0.05569551	1.61850321	0.068987309	0.071037161	0.041133619	0	0.023228475	0.114367944	0.4221274	31.27114391	0.095901908	4.041740216	0.038531479	0	0.0244493	0	0.029479	0.072700949	0.040484	7.994557283	45.18405067	0.022592025
	Galveston	0.02755599	0.80077278	0.033893644	0.034900741	0.020351324	0	0.012791501	0.062980361	0.2014466	14.92314082	0.045812515	1.930746628	0.019823685	0	0.0167751	0	0.594657	1.466526936	0.028709	5.66936644	24.88843471	0.012444217
	Harris	0.07736057	2.2480866	0.09582276	0.098669986	0.057134232	0	0.032264145	0.158856061	0.5863312	43.43534163	0.1332069	5.613941324	0.053519883	0	0.0339599	0	0.040946	0.100980974	0.056232	11.10436918	62.76024576	0.031380123
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.00176365	0.05125137	0.003151138	0.003244769	0.001302533	0	0.005050143	0.024864932	0.0020858	0.154512186	0.00060408	0.025458663	0.015958397	0	0.0637888	0	0.000846	0.002086719	0.004013	0.792503593	1.053922234	0.000526961
	Dallas	0.00504555	0.14662301	0.005305276	0.005462914	0.003726366	0	0.008757286	0.043117461	0.0024131	0.178761156	0.000782263	0.032968113	0.009310387	0	0.033672	0	0.008209	0.020245272	0.044002	8.689281071	9.116458995	0.004558229
	Denton	0.00063576	0.01847503	0.001170951	0.001205744	0.000469535	0	0.001874207	0.009227864	0.0007854	0.058184615	0.000226691	0.009553778	0.006095882	0	0.0243999	0	0.00025	0.000617407	0.00114	0.225033768	0.322298201	0.000161149
	Tarrant	0.01557224	0.45252704	0.015705165	0.01617182	0.011500796	0	0.026002176	0.12802457	0.006807	0.504260566	0.002243821	0.094564751	0.022183886	0	0.0770985	0	0.02638	0.06505674	0.141667	27.9755603	29.23616579	0.014618083
	Ellis	0.00350282	0.10179153	0.003532723	0.003637693	0.002586991	0	0.005848935	0.028797873	0.0015312	0.113428476	0.000504725	0.021271415	0.004990048	0	0.0173426	0	0.005934	0.014633877	0.031867	6.292828323	6.576389183	0.003288195
	Johnson	0.00033718	0.00979828	0.000621017	0.00063947	0.00024902	0	0.000993991	0.004894025	0.0004166	0.030858382	0.000120226	0.005066874	0.003232969	0	0.0129406	0	0.000133	0.000327443	0.000604	0.119347322	0.170931801	8.54659E-05
	Kaufman	0.00649275	0.18867841	0.006548174	0.006742743	0.004795187	0	0.01084145	0.053379069	0.0028381	0.21024839	0.000935547	0.0394282	0.009249437	0	0.0321458	0	0.010999	0.027125014	0.059067	11.66424047	12.1898423	0.006094921
	Parker	0.00047595	0.01383108	0.000876616	0.000902664	0.000351511	0	0.0014031	0.006908317	0.000588	0.043559135	0.000169709	0.007152308	0.0045636	0	0.0182667	0	0.000187	0.000462213	0.000853	0.168468525	0.241284244	0.000120642
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.00095027	0.02761473	0.000958382	0.000986859	0.000701818	0	0.001586741	0.007812493	0.0004154	0.030771688	0.000136926	0.005770662	0.001353736	0	0.0047048	0	0.00161	0.003969983	0.008645	1.707163485	1.784089904	0.000892045
	Hood	0.01232788	0.35824639	0.012433111	0.012802542	0.00910469	0	0.020584816	0.101351602	0.0053888	0.399201621	0.001776337	0.074862887	0.017562038	0	0.0610356	0	0.020884	0.051502651	0.112152	22.14706	23.14502769	0.011572514
	Hunt	0.00635121	0.18456524	0.006405424	0.006595752	0.004690653	0	0.010605108	0.052215412	0.0027763	0.205664998	0.000915153	0.03856867	0.0090478	0	0.031445	0	0.010759	0.026533692	0.05778	11.40996133	11.9241051	0.005962053
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.03112811	0.9045783	0.048234164	0.049667368	0.0229895	0	0.084461674	0.415856326	0.0010637	0.078801326	1.065346769	44.89853197	0.043667482	0	0.0043501	0	0.000484	0.001193729	0.002333	0.460625665	46.80925468	0.023404627
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.00200761	0.05834086	0.076651484	0.078929065	0.00148271	0	0.134326688	0.661372196	0.0012416	0.091973896	0.00356749	0.150350167	0.001065557	0	0.0018623	0	0.000403	0.000994245	0.001842	0.363691159	1.40565159	0.000702826
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.00446951	0.12988342	0.170648096	0.175718642	0.003300936	0	0.299049574	1.472403407	0.002764	0.204760161	0.007942252	0.334722414	0.002372235	0	0.0041461	0	0.000898	0.002213474	0.0041	0.809680397	3.129381915	0.001564691
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.00246935	0.07175902	0.094281013	0.097082428	0.001823727	0	0.165221279	0.813485108	0.0015271	0.113127517	0.004387998	0.184930093	0.001310631	0	0.0022907	0	0.000496	0.001222918	0.002265	0.447338645	1.728945731	0.000864473
	Travis	0.00050761	0.01475105	0.298194277	0.307054662	0.000374892	0	0.033779905	0.166319069	0.0003331	0.024678605	0.000901861	0.038008491	0.000269863	0	0.0004695	0	0.000103	0.000253624	0.000465	0.0918527	0.642918196	0.000321459
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22352453	6.49558905	0.00447587	0.004608863	0.165082827	0	0.007477478	0.036816183	0.001651	0.122307068	0.001597886	0.067342128	0.045960479	0	0.0071176	0	0.001581	0.003898589	0.008136	1.606684378	8.337246261	0.004168623
	San Patricio	0.05533089	1.60790722	0.001107949	0.00114087	0.040864326	0	0.001850962	0.009113416	0.0004087	0.030275687	0.000395538	0.016669757	0.01137698	0	0.0017619	0	0.000391	0.00096505	0.002014	0.397715956	2.063787957	0.001031894
Victoria Area	Victoria	0.02060475	0.59877099	0.002090584	0.002152702	0.015217528	0	0.003408874	0.016783968	0.0011319	0.083854042	0.000524055	0.022086044	0.495811308	0	0.0305841	0	0.00045	0.001109661	0.002128	0.420152343	1.144909752	0.000572455
Other ERCOT counties	Andrews	2.5653E-05	0.00074546	2.58716E-05	2.66404E-05	1.89456E-05	0	4.28342E-05	0.000210899	1.121E-05	0.000830685	3.69632E-06	0.00015578	3.65442E-05	0	0.000127	0	4.35E-05	0.00010717	0.000233	0.046085051	0.048161687	2.40808E-05
	Angelina	0.00032149	0.00934246	0.000324234	0.000333868	0.000237435	0	0.000536817	0.002643077	0.0001405	0.010410498	4.63239E-05	0.001952297	0.000457988	0	0.0015917	0	0.000545	0.001343101	0.002925	0.577557604	0.603582902	0.000301791
	Bosque	0.00093945	0.02730035	0.001730301	0.001781715	0.000693828	0	0.002769496	0.013635918	0.0011606	0.085978798	0.000334979	0.014117518	0.009007821	0	0.0360555	0	0.00037	0.000912335	0.001684	0.332530047	0.476256684	0.000238128
	Brazos	0.00191393	0.05561841	0.003525105	0.003629848	0.00141352	0	0.005642234	0.027780157	0.0023645	0.175162719	0.000682445	0.028761309	0.018351436	0	0.073455	0	0.000754	0.001858681	0.003431	0.677456172	0.970267297	0.000485134
	Calhoun	0.08852525	2.57253032	0.001772635	0.001825307	0.065379841	0	0.0029614	0.014580779	0.0006539	0.048438816	0.000632831	0.026670355	0.01820231	0	0.0028189	0	0.000626	0.001544008	0.003222	0.636315543	3.301905128	0.001650953
	Cameron	0.05467229	1.58876844	0.001094762	0.001127291	0.285623104	0	0.001828931	0.00900494	0.0004038	0.029915318	0.00039083	0.016471339	0.011241561	0	0.0017409	0	0.000387	0.000953563	0.00199	0.392981979	2.039222874	0.001019611
	Cherokee	0.003513	0.10208711	0.003542982	0.003648256	0.002594504	0	0.005865919	0.028881497	0.0015356	0.11375785	0.000506191	0.021333183	0.005004538	0	0.0173929	0	0.005951	0.01467637	0.031959	6.31110147	6.595485735	0.003297743
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.0013551	0.03937898	2.71346E-05	2.79409E-05	0.001000801	0	4.53316E-05	0.000223195	1.001E-05	0.000741477	9.68705E-06	0.000408256	0.000278632	0	4.315E-05	0	9.58E-06	2.36349E-05	4.93E-05	0.009740394	0.050543881	2.52719E-05
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.00362926	0.10546585	0.003660242	0.003769001	0.002680373	0	0.006060061	0.029837378	0.0015864	0.117522856	0.000522944	0.02203924	0.005170172	0	0.0179686	0	0.006148	0.015162109	0.033017	6.51997905	6.813774343	0.003406887
	Fannin	0.00762852	0.22168353	0.007693632	0.007922236	0.005633999	0	0.012737922	0.062716559	0.0033346	0.247026702	0.001099201	0.046325293	0.010867422	0	0.0377689	0	0.012923	0.031869936	0.0694	13.70464171	14.32218597	0.007161093
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.00377443	0.10968449	0.003806652	0.003919761	0.002787588	0	0.006302464	0.031030873	0.0016499	0.12222377	0.000543862	0.02292081	0.005376978	0	0.0186873	0	0.006394	0.015768594	0.034338	6.780770021	7.086325316	0.003543163
	Frio	0.01476384	0.42903492	0.001497957	0.001542467	0.010903753	0	0.002442547	0.012026147	0.0008111	0.060083591	0.000375499	0.015825222	0.355261637	0	0.0219143	0	0.000322	0.000795101	0.001525	0.30105003	0.820357475	0.000410179
	Grimes	0.00055442	0.01611148	0.001021149	0.001051491	0.000409467	0	0.001634436	0.008047327	0.0006849	0.050740957	0.00019769	0.008331547	0.005316025	0	0.0212784	0	0.000218	0.000538421	0.000994	0.196244809	0.281066035	0.000140533
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.239737	6.96672099	0.004800509	0.004943149	0.177056459	0	0.008019827	0.0394865	0.0017708	0.131178129	0.001713782	0.072226524	0.049294041	0	0.0076338	0	0.001695	0.004181358	0.008726	1.723218895	8.941955549	0.004470978
	Howard	0.00058508	0.01700236	0.000590075	0.000607608	0.000432108	0	0.000976955	0.004810144	0.0002558	0.018946096	8.43049E-05	0.003553299	0.000833494	0	0.0028967	0	0.000991	0.002444314	0.005323	1.051098725	1.098462239	0.000549231
	Jack	0.00217756	0.06327951	0.002196145	0.002261401	0.001608224	0	0.003636037	0.017902427	0.0009519	0.070513714	0.000313767	0.013223544	0.003102103	0	0.0107811	0	0.003689	0.009097266	0.01981	3.911986743	4.088264606	0.002044132
	Jones	0.04250012	1.2350472	0.000851025	0.000876312	0.031388236	0	0.00142174	0.007000092	0.0003139	0.023255012	0.000303816	0.012804182	0.008738755	0	0.0013533	0	0.000301	0.000741263	0.001547	0.305489005	1.585213062	0.000792607
	Lamar	0.00107998	0.03138407	0.001089199	0.001121563	0.000797614	0	0.001803327	0.008878877	0.0004721	0.03497194	0.000155616	0.006558341	0.001538517	0	0.005347	0	0.00183	0.004511875	0.009825	1.94018666	2.027613326	0.001013807
	Limestone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Llano	0.00124346	0.03613476	0.047475864	0.048886536	0.000918351	0	0.083198331	0.409636117	0.000769	0.056966153	0.002209607	0.093122842	0.000659977	0	0.0011535	0	0.00025	0.000615809	0.001141	0.225260504	0.870622718	0.000435311
	McLennan	0.02303137	0.6692881	0.023227961	0.023918144	0.017009692	0	0.038457253	0.189348509	0.0100675	0.745802046	0.003318614	0.139861392	0.032809997	0	0.1140288	0	0.039015	0.096219005	0.209526	41.37589079	43.24032799	0.021620164
	Milam	0.00165249	0.04802117	0.001666598	0.001716118	0.001220439	0	0.002759294	0.013585685	0.0007223	0.053511019	0.000238109	0.010035003	0.002354105	0	0.0081815	0	0.002799	0.006903678	0.015033	2.96870474	3.102477414	0.001551239
	Mitchell	0.01696145	0.49289727	0.017106233	0.017614519	0.012526789	0	0.028321847	0.139445724	0.0074142	0.549245973	0.002443993	0.103000932	0.024162925	0	0.0839765	0	0.028733	0.070860493	0.154305	30.47127789	31.8443428	0.015922171
	Nolan	0.00060327	0.01753102	0.000608422	0.000626501	0.000445544	0	0.001007331	0.004959706	0.0002637	0.01953519	8.69262E-05	0.003663464	0.00085941	0	0.0029868	0	0.001022	0.002520316	0.005488	1.083780729	1.132616924	0.000566308
	Palo Pinto	0.00307488	0.08935553	0.00566337	0.005831648	0.002270935	0	0.00906471	0.044631095	0.0037988	0.281413244	0.001096403	0.046207397	0.029483083	0	0.1180115	0	0.001211	0.002986123	0.005512	1.088388783	1.558813821	0.000779407
	Pecos	4.2262E-05	0.00122812	4.26225E-05	4.3889E-05	3.12122E-05	0	7.05678E-05	0.000347448	1.847E-05	0.001368522	6.08954E-06	0.000256641	6.02052E-05	0	0.0002092	0	7.16E-05	0.000176559	0.000384	0.075923359	0.079344538	3.96723E-05
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.00035926	0.01043997	0.000406685	0.000418769	0.000265328	0	0.000358385	0.00176455	0.0015339	0.113628648	0.00035593	0.015000506	0.000370532	0	0.0009089	0	0.093323	0.230151898	0.001655	0.326754003	0.698158342	0.000349079
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tom Green	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upton	3.2238E-05	0.00093683	3.25131E-05	3.34792E-05	2.38092E-05	0	5.38302E-05	0.000265039	1.409E-05	0.00104393	4.6452E-06	0.00019577	4.59255E-05	0	0.0001596	0	5.46E-05	0.000134682	0.000293	0.05791553	0.060525259	3.02626E-05
	Ward	0.01980763	0.57560662	0.0199767	0.020570277	0.014628815	0	0.033074321	0.162845052	0.0086584	0.64141077	0.002854101	0.120284737	0.028217522	0	0.098068	0	0.033554	0.082751055	0.180198	35.58443168	37.18790019	0.01859395
	Webb	0.01418005	0.41206999	0.000283942	0.000292379	0.010472596	0	0.000474359	0.002335561	0.0001047	0.007758969	0.000101367	0.004272079	0.002915661	0	0.0004515	0	0.0001	0.00024732	0.000516	0.101925539	0.528901838	0.000264451
	Wharton	0.00015439	0.00448655	0.000191235	0.000196918	0.000114024	0	6.43902E-05	0.000317032	0.0011702	0.086684748	0.000265844	0.011203851	0.000106811	0	6.777E-05	0	8.17E-05	0.00020153	0.000112	0.022161203	0.125251831	6.26259E-05
	Wichita	0.00021984	0.0063886	0.000221719	0.000228308	0.000162364	0	0.000367089	0.001807402	9.61E-05	0.007118957	3.16774E-05	0.001335029	0.000313184	0	0.0010884	0	0.000372	0.000918446	0.002	0.394948206	0.41274495	0.000206372
	Wilbarger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Wise	0.00291847	0.08481033	0.002955932	0.003043763	0.002155421	0	0.004892446	0.024088495	0.0012878	0.095396583	0.000423725	0.017857705	0.004280539	0	0.0149528	0	0.004924	0.012144313	0.026441	5.221313004	5.458654189	0.002729327
	Young	0.00549666	0.15973212	0.005543579	0.005708298	0.004059529	0	0.009178198	0.045189864	0.0024027	0.177992915	0.000792019	0.033379282	0.007830425	0	0.0272141	0	0.009311	0.022963602	0.050005	9.874758944	10.31972502	0.005159863
	Total	1.14303735	33.2164934	1.154658244	1.188967139	1.089429227	0	1.180868675	5.814136562	1.5393506	114.0348967	1.443965054	60.85521919	1.48172714	0	1.2697054	0	1.151969	2.840955914	1.517783	299.722395	517.673064	0.258836532

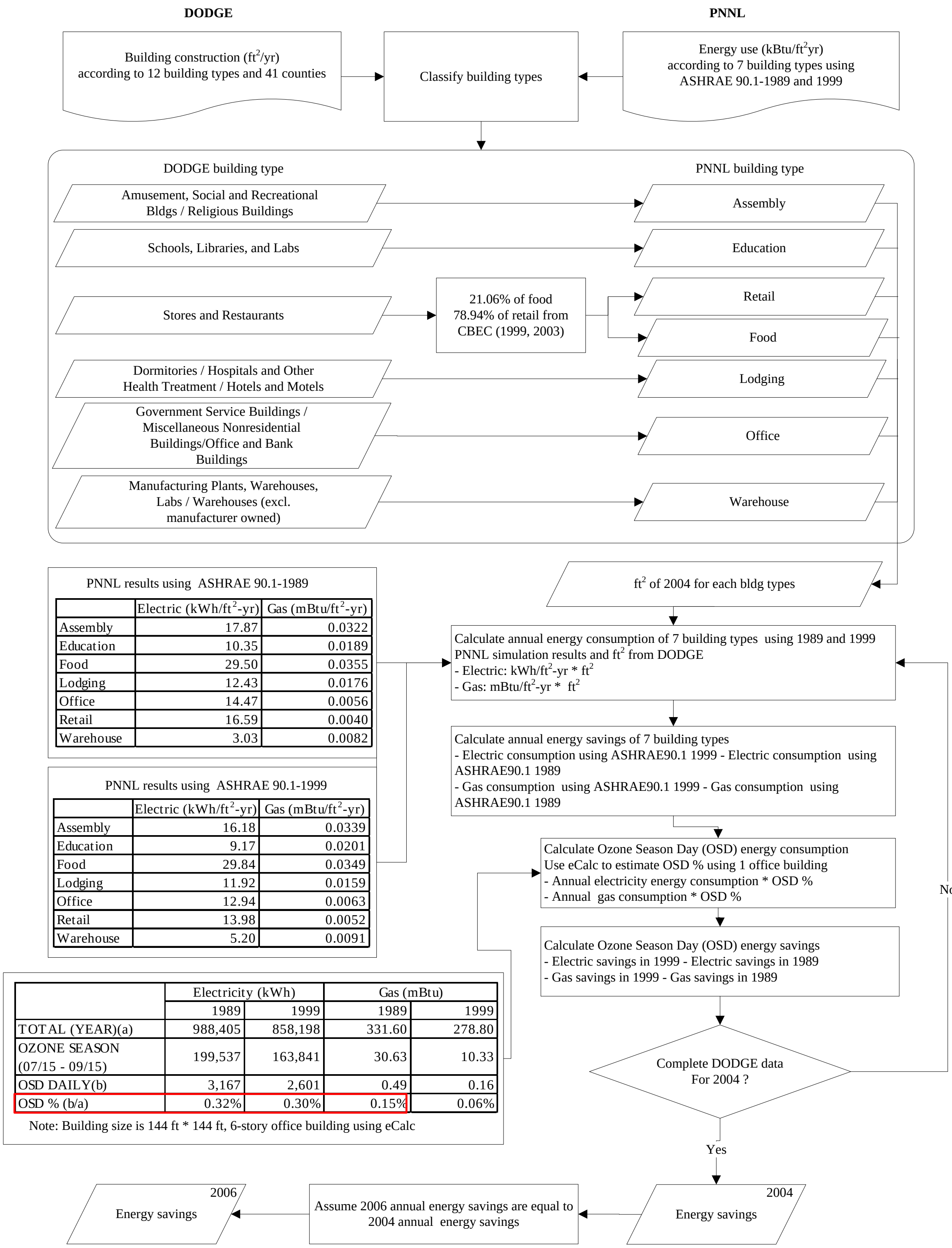
Energy Savings by PCA (MWh)		American Electric Power - West (ERCOT) /PCA		Austin Energy/PCA		Brownsville Public Utils Board/PCA		Lower Colorado River Auhotrity /PCA		Reliant Energy HL&P/PCA		San Antonio Public Service Bd/PCA		South Texas Electric Coop INC/PCA		Texas Municipal Power Pool/PCA		Texas-New Mexico Power Co/PCA		TXU Electric/PCA
		29.06		1.03		0.00		4.92		74.08		42.14		0.00		0.00		2.47		197.47

Table 53

Table 53 and Table 54 shows the transformation of the annual and OSD county-wide electricity and natural gas savings, along with the associated 1999 NOx emissions reductions with 7% T&D losses. Figure 88 and Figure 89 show the bar chart of the annual and OSD electricity savings for 2009, respectively. Figure 90 and Figure 91 present the NOx emissions reductions from the electricity use savings using the 2007 eGRID for Texas.

6.1.5 2009 Results for New Residential (Single-family and Multi-family), and Commercial Construction using 2007 eGRID

Using the 2007 eGRID, the total NOx reductions from electricity and natural gas savings from new commercial construction in 2009 are calculated to be 38.51 tons NOx/year which represents 41.35 tons NOx/year from electricity savings and an increase of 2.84 tons NOx/year from natural gas. On a peak Ozone Season Day (OSD), the NOx reductions in 2008 are calculated to be 0.31 tons of NOx/day which represents 0.26 tons NOx/day from electricity savings and 0.05 tons NOx/day from natural gas savings.



PNNL results using ASHRAE 90.1-1989

	Electric (kWh/ft²-yr)	Gas (mBtu/ft²-yr)
Assembly	17.87	0.0322
Education	10.35	0.0189
Food	29.50	0.0355
Lodging	12.43	0.0176
Office	14.47	0.0056
Retail	16.59	0.0040
Warehouse	3.03	0.0082

PNNL results using ASHRAE 90.1-1999

	Electric (kWh/ft²-yr)	Gas (mBtu/ft²-yr)
Assembly	16.18	0.0339
Education	9.17	0.0201
Food	29.84	0.0349
Lodging	11.92	0.0159
Office	12.94	0.0063
Retail	13.98	0.0052
Warehouse	5.20	0.0091

	Electricity (kWh)		Gas (mBtu)	
	1989	1999	1989	1999
TOTAL (YEAR)(a)	988,405	858,198	331.60	278.80
OZONE SEASON (07/15 - 09/15)	199,537	163,841	30.63	10.33
OSD DAILY(b)	3,167	2,601	0.49	0.16
OSD % (b/a)	0.32%	0.30%	0.15%	0.06%

Note: Building size is 144 ft * 144 ft, 6-story office building using eCalc

Figure 79: Analysis Method for Calculating the 2008 Energy and Emissions Savings from Commercial Buildings (Updated)

Table 22: Commercial Building Descriptions from USDOE (2004) Report and Dodge (2005)

No	PNNL Bldg Types	Dodge Bldg Types
1	Assembly	Amusement, Social and Recreational Bldgs
2		Religious Buildings
3	Education	Schools, Libraries, and Labs (nonmfg)
4	Retail	Stores and Restaurants
5	Food	Stores and Restaurants
6	Lodging	Dormitories
7		Hospitals and Other Health Treatment
8		Hotels and Motels
9	Office	Government Service Buildings
10		Miscellaneous Nonresidential Buildings
11		Office and Bank Buildings
12	Warehouse	Manufacturing Plants, Warehouses, Labs
13		Warehouses (excl. manufacturer owned)

Table 23: Floor Area from CBEC (1999, 2003) Database for Retail and Food Type Commercial Buildings

		CBEC (1999)		CBEC (2003)	
		All (million square feet)	South (million square feet)	All (million square feet)	South (million square feet)
Food	Food Sales	994	392	1,255	487
	Food Service	1851	676	1,654	764
Retail	Retail (Other Than Mall)	4766	1566	4,317	1,844
	Enclosed and Strip Malls	5631	2513	6,875	3,251

	South		All	
	Food %	Retail %	Food %	Retail %
CBEC (1999)[32]	20.75	79.25	21.48	78.52
CBEC (2003)[33]	19.71	80.29	20.63	79.37
Average	20.23	79.77	21.06	78.94

[32] http://www.eia.doe.gov/emeu/cbecs/pdf/alltables.pdf, pg. 4
[33] http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/seta.pdf, pg. 1

Table 24: 2009 New Commercial Building Construction (sq. ft. x 1000) [34]

Table shows Dodge (2005) data before merging into PNNL building types (sq. ft. x 1000) (Part 1)

County	Assembly	Education	Retail	Food	Lodging	Office	Warehouse
HARRIS	1424	2949	2360	630	1642	2392	4792
TARRANT	737	1564	1667	445	1003	902	1875
COLLIN	459	974	1131	302	487	683	490
DALLAS	909	1769	1283	342	865	2020	2910
BEXAR	532	1781	1141	305	1202	886	904
TRAVIS	315	525	646	172	652	527	398
DENTON	327	1041	621	166	383	315	758
WILLIAMSON	116	399	305	81	123	134	119
EL PASO	295	746	343	92	300	461	1116
MONTGOMERY	176	477	408	109	195	321	204
GALVESTON	84	197	173	46	106	174	62
BRAZORIA	94	366	237	63	57	70	115
COMAL	25	145	71	19	47	52	28
ROCKWALL	26	158	95	25	15	26	36
HAYS	75	219	121	32	59	137	65
NUECES	102	150	70	19	162	121	124
FORT BEND	211	546	454	121	182	347	484
ELLIS	46	117	63	17	21	26	300
JOHNSON	9	134	51	14	4	8	64
GUADALUPE	21	140	69	18	38	66	142
KAUFMAN	20	118	28	8	5	15	79
JEFFERSON	88	117	165	44	245	102	48
PARKER	10	130	71	19	37	8	6
SMITH	80	113	87	23	120	121	147
BASTROP	5	53	16	4	45	6	6
CHAMBERS	7	33	5	1	0	13	0
GREGG	48	33	45	12	80	25	42
SAN PATRICIO	13	56	23	6	19	75	241
LIBERTY	5	171	13	3	6	15	2
VICTORIA	17	16	29	8	20	17	10
ORANGE	11	107	17	5	19	18	15
CALDWELL	2	60	12	3	6	2	11
WILSON	2	24	5	1	10	0	0
HARDIN	6	38	13	3	0	1	0
HARRISON	39	61	32	9	33	13	10
WALLER	3	12	0	0	0	0	14
UPSHUR	11	29	4	1	2	5	2
RUSK	1	6	11	3	1	2	2
HOOD	34	62	12	3	6	10	0
HUNT	17	80	14	4	13	18	11
HENDERSON	4	21	9	2	2	3	17
HIDALGO	0	0	0	0	0	0	0
CAMERON	80	390	169	45	215	170	298
BELL	78	257	88	23	326	162	118
WEBB	28	275	53	14	95	78	118
BRAZOS	150	293	106	28	209	188	54
KENDALL	0	0	0	0	0	0	0
BURNET	7	51	10	3	9	12	2
GRAYSON	25	113	43	12	35	17	90
CORYELL	13	35	19	5	16	4	7
MIDLAND	88	59	89	24	51	59	18
LLANO	1	24	0	0	56	4	0
MAVERICK	13	41	12	3	28	24	1
MCMULLEN	2	1	0	0	0	1	0
ARANSAS	4	1	26	7	7	14	0
WICHITA	59	50	51	13	165	57	28
TAYLOR	34	49	80	21	60	32	52
TOM GREEN	61	89	52	14	112	40	33
MCLENNAN	71	266	99	26	122	92	121
MCCULLOCH	0	9	0	0	0	0	0
WISE	18	73	1	0	47	19	0
JIM HOGG	0	8	0	0	1	10	0
VAL VERDE	9	29	7	2	9	27	3
ECTOR	28	92	38	10	125	22	219
WHARTON	9	16	30	8	6	6	11
KERR	43	50	23	6	53	26	0
PRESIDIO	3	5	0	0	0	1	0
JIM WELLS	0	47	22	6	23	7	4
CALHOUN	0	11	18	5	1	21	0
GILLESPIE	8	6	13	3	7	2	5
MATAGORDA	4	26	5	1	9	6	7
NAVARRO	3	30	18	5	14	2	34
ANGELINA	33	53	45	12	29	21	7
NACOGDOCHES	22	117	19	5	27	14	13
FANNIN	6	20	3	1	4	2	5
ATASCOSA	11	21	11	3	9	2	2
WASHINGTON	30	36	33	9	12	13	25
LAMAR	4	29	5	1	2	5	2
VAN ZANDT	1	41	0	0	0	1	0
WILLACY	2	42	27	7	1	26	7
BROWN	5	15	8	2	12	10	6
ERATH	4	31	2	1	8	2	2
AUSTIN	1	38	1	0	5	1	194
COOKE	21	76	50	13	66	16	19
MEDINA	3	20	1	0	0	11	1
TITUS	4	26	7	2	0	2	0
UVALDE	14	32	33	9	5	7	8
FAYETTE	2	14	3	1	15	4	1
CALLAHAN	3	18	0	0	0	3	1
HOPKINS	5	17	10	3	5	2	12
LAMPASAS	2	9	12	3	7	4	0
BLANCO	0	18	0	0	0	0	0
FREESTONE	0	8	0	0	1	1	0
GRIMES	3	8	0	0	0	4	0
LEE	1	13	1	0	0	5	0
SOMERVELL	0	7	0	0	1	5	1
ANDREWS	1	6	0	0	3	0	0
BORDEN	0	0	0	0	0	0	0
CHEROKEE	37	56	10	3	26	21	34
DIMMIT	0	3	0	0	0	6	0

[34] Source: Dodge/McGraw-Hill 2007

Table 25: 2009 New Commercial Building Construction (sq. ft. x 1000)[35]

Table shows Dodge (2005) data before merging into PNNL building types (sq. ft. x 1000) (Part 2)

County	Assembly	Education	Retail	Food	Lodging	Office	Warehouse
FALLS	0	0	0	0	0	0	0
COLORADO	0	17	0	0	4	8	0
FRIO	0	16	4	1	2	1	0
MILAM	3	39	10	3	0	19	0
JACKSON	1	16	1	0	0	0	0
ANDERSON	1	1	2	1	2	2	1
HILL	4	49	7	2	3	1	0
CULBERSON	1	8	0	0	0	1	0
MASON	0	1	0	0	0	2	0
PECOS	3	6	0	0	9	11	0
RAINS	1	8	0	0	0	1	0
LAVACA	7	2	0	0	1	2	0
PALO PINTO	4	26	15	4	3	2	2
KIMBLE	2	0	0	0	0	2	0
MADISON	1	10	0	0	0	0	0
ARCHER	1	17	0	0	4	0	2
REFUGIO	1	1	0	0	0	2	0
LIMESTONE	3	5	9	2	4	9	0
CLAY	0	3	0	0	0	5	0
BEE	19	49	5	1	21	19	0
MARTIN	0	0	0	0	0	0	0
GONZALES	0	4	1	0	2	1	0
BURLESON	1	12	1	0	2	8	0
KARNES	0	7	0	0	1	5	0
KLEBERG	6	38	33	9	8	6	1
BREWSTER	4	11	0	0	6	10	6
WINKLER	1	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	26
YOUNG	10	21	23	6	6	4	2
HOUSTON	2	5	17	5	7	2	0
SCURRY	1	0	4	1	2	1	12
BOSQUE	1	16	0	0	0	1	0
COMANCHE	7	36	1	0	72	0	2
BRISCOE	0	0	0	0	0	0	0
CONCHO	0	0	0	0	0	2	0
ZAVALA	0	5	0	0	1	1	0
NOLAN	6	17	10	3	8	0	0
BROOKS	0	0	0	0	0	9	0
ROBERTSON	1	3	0	0	1	0	1
LIVE OAK	10	0	0	0	0	0	0
HAMILTON	0	6	0	0	4	0	0
JONES	8	8	0	0	0	0	4
REAGAN	1	0	0	0	0	8	0
WARD	0	0	0	0	0	7	0
RED RIVER	2	14	0	0	0	0	0
HASKELL	0	0	9	2	0	14	0
HOWARD	4	10	1	0	5	3	0
SAN SABA	4	3	1	0	0	0	0
JACK	1	1	0	0	0	17	0
STEPHENS	0	6	0	0	1	0	0
RUNNELS	0	6	1	0	0	2	0
REEVES	5	2	0	0	4	47	0
DE WITT	0	0	0	0	0	0	0
CHILDRESS	0	0	0	0	0	0	0
CROSBY	1	0	0	0	1	0	0
DAWSON	0	7	0	0	0	16	0
MITCHELL	4	0	0	0	5	14	0
WILBARGER	3	7	9	2	11	17	1
COLEMAN	1	1	0	0	1	1	0
UPTON	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0
CROCKETT	3	2	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0
BANDERA	0	0	0	0	0	0	0
BAYLOR	0	1	0	0	2	0	0
COTTLE	0	2	0	0	0	0	0
CRANE	1	1	0	0	0	0	0
DELTA	0	3	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0
DUVAL	0	20	1	0	0	4	0
EASTLAND	7	4	20	5	1	4	0
EDWARDS	0	0	0	0	0	0	0
FISHER	0	3	0	0	2	0	0
FOARD	0	0	0	0	0	0	0
GLASSCOCK	0	0	0	0	0	0	0
GOLIAD	0	4	0	0	0	1	0
HALL	0	1	0	0	0	0	0
HUDSPETH	1	9	0	0	0	13	0
IRION	0	0	0	0	0	0	0
JEFF DAVIS	6	0	0	0	0	2	0
KENEDY	0	0	0	0	0	1	0
KENT	0	0	0	0	2	0	0
KING	0	0	0	0	0	0	0
KINNEY	0	3	0	0	0	23	0
KNOX	1	1	0	0	0	0	0
LA SALLE	0	1	0	0	2	0	0
LEON	7	7	0	0	0	0	0
LOVING	0	0	0	0	0	0	0
MENARD	0	1	0	0	0	0	0
MILLS	2	8	0	0	0	1	0
MONTAGUE	1	13	10	3	6	5	1
MOTLEY	0	1	0	0	0	0	0
REAL	0	1	0	0	4	1	0
SCHLEICHER	0	0	0	0	0	0	0
SHACKELFORD	2	4	0	0	2	0	0
STARR	0	0	0	0	0	0	0
STERLING	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0
SUTTON	0	2	0	0	1	1	0
TERRELL	0	0	0	0	0	6	0
THROCKMORTON	1	0	0	0	0	1	0
ZAPATA	2	40	1	0	1	12	0
TOTAL	7632	19555	13469	3593	10475	11788	17272

[35] Source: Dodge/McGraw-Hill 2007

Table 26: 2009 New Commercial Building Construction (sq. ft. x 1000)[36]

Table shows Dodge (2005) data merged into PNNL building types (sq. ft. x 1000) (Part 1)

(square feet in thousands)

Non-attainment Counties	Assembly	Education	Retail	Food	Lodging	Office	Warehouse	Stores and Restaurants
BRAZORIA	94	366	237	63	57	70	115	514
CHAMBERS	7	33	5	1	0	13	0	0
COLLIN	459	974	1,131	302	487	683	490	1,580
DALLAS	909	1,769	1,283	342	865	2,020	2,910	2,004
DENTON	327	1,041	621	166	383	315	758	907
EL PASO	295	746	343	92	300	461	1,116	537
FORT BEND	211	546	454	121	182	347	484	370
GALVESTON	84	197	173	46	106	174	62	426
HARDIN	6	38	13	3	0	1	0	0
HARRIS	1,424	2,949	2,360	630	1,642	2,392	4,792	4,778
JEFFERSON	88	117	165	44	245	102	48	195
LIBERTY	5	171	13	3	6	15	2	9
MONTGOMERY	176	477	408	109	195	321	204	452
ORANGE	11	107	17	5	19	18	15	104
TARRANT	737	1,564	1,667	445	1,003	902	1,875	2,836
WALLER	3	12	0	0	0	0	14	22
TOTAL (NON-ATTAINMENT)	4,836	11,106	8,892	2,372	5,490	7,833	12,884	14,734

Affected Counties	Assembly	Education	Retail	Food	Lodging	Office	Warehouse	Stores and Restaurants
BASTROP	5	53	16	4	45	6	6	29
BEXAR	532	1,781	1,141	305	1,202	886	904	1,735
CALDWELL	2	60	12	3	6	2	11	4
COMAL	25	145	71	19	47	52	28	152
ELLIS	46	117	63	17	21	26	300	87
GREGG	48	33	45	12	80	25	42	13
GUADALUPE	21	140	69	18	38	66	142	387
HARRISON	39	61	32	9	33	13	10	4
HAYS	75	219	121	32	59	137	65	405
HENDERSON	4	21	9	2	2	3	17	2
HOOD	34	62	12	3	6	10	0	0
HUNT	17	80	14	4	13	18	11	15
JOHNSON	9	134	51	14	4	8	64	193
KAUFMAN	20	118	28	8	5	15	79	194
NUECES	102	150	70	19	162	121	124	103
PARKER	10	130	71	19	37	8	6	532
ROCKWALL	26	158	95	25	15	26	36	152
RUSK	1	6	11	3	1	2	2	140
SAN PATRICIO	13	56	23	6	19	75	241	161
SMITH	80	113	87	23	120	121	147	64
TRAVIS	315	525	646	172	652	527	398	1,436
UPSHUR	11	29	4	1	2	5	2	0
VICTORIA	17	16	29	8	20	17	10	15
WILLIAMSON	116	399	305	81	123	134	119	946
WILSON	2	24	5	1	10	0	0	74
TOTAL (AFFECTED)	1,570	4,630	3,030	808	2,723	2,302	2,763	6,843

[36] Source: Dodge/McGraw-Hill 2007

Table 27: 2009 New Commercial Building Construction (sq. ft. x 1000)[37]

Table shows Dodge (2005) data merged into PNNL building types (sq. ft. x 1000) (Part 2)

ERCOT Counties	Assembly	Education	Retail	Food	Lodging	Office	Warehouse	Stores and Restaurants
ANDERSON	1	1	2	1	2	2	1	28
ANDREWS	1	6	0	0	3	0	0	0
ANGELINA	33	53	45	12	29	21	7	134
ARANSAS	4	1	26	7	7	14	0	160
ARCHER	1	17	0	0	4	0	2	0
ATASCOSA	11	21	11	3	9	2	2	3
AUSTIN	1	38	1	0	5	1	194	0
BANDERA	0	0	0	0	0	0	0	0
BASTROP	0	0	0	0	0	0	0	29
BAYLOR	0	1	0	0	2	0	0	0
BEE	19	49	5	1	21	19	0	0
BELL	78	257	88	23	326	162	118	510
BEXAR	532	1,781	1,141	305	1,202	886	904	1,735
BLANCO	0	18	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0
BOSQUE	1	16	0	0	0	1	0	0
BRAZORIA	94	366	237	63	57	70	115	514
BRAZOS	150	293	106	28	209	188	54	158
BREWSTER	4	11	0	0	6	10	6	0
BRISCOE	0	0	0	0	0	0	0	0
BROOKS	0	0	0	0	0	9	0	0
BROWN	5	15	8	2	12	10	6	105
BURLESON	1	12	1	0	2	8	0	0
BURNET	7	51	10	3	9	12	2	28
CALDWELL	0	0	0	0	0	0	0	4
CALHOUN	0	11	18	5	1	21	0	155
CALLAHAN	3	18	0	0	0	3	1	0
CAMERON	80	390	169	45	215	170	298	512
CHAMBERS	7	33	5	1	0	13	0	0
CHEROKEE	37	56	10	3	26	21	34	6
CHILDRESS	0	0	0	0	0	0	0	0
CLAY	0	3	0	0	0	5	0	0
COKE	0	0	0	0	0	0	0	0
COLEMAN	1	1	0	0	1	1	0	0
COLLIN	459	974	1,131	302	487	683	490	1,580
COLORADO	0	17	0	0	4	8	0	0
COMAL	25	145	71	19	47	52	28	152
COMANCHE	7	36	1	0	72	0	2	0
CONCHO	0	0	0	0	0	2	0	0
COOKE	21	76	50	13	66	16	19	0
CORYELL	13	35	19	5	16	4	7	155
COTTLE	0	2	0	0	0	0	0	0
CRANE	1	1	0	0	0	0	0	0
CROCKETT	3	2	0	0	0	0	0	0
CROSBY	1	0	0	0	1	0	0	0
CULBERSON	1	8	0	0	0	1	0	0
DALLAS	0	0	0	0	0	0	0	2,004
DAWSON	0	7	0	0	0	16	0	0
DE WITT	0	0	0	0	0	0	0	0
DELTA	0	3	0	0	0	0	0	0
DENTON	0	0	0	0	0	0	0	907
DICKENS	0	0	0	0	0	0	0	0
DIMMIT	0	3	0	0	0	6	0	0
DUVAL	0	20	1	0	0	4	0	0
EASTLAND	7	4	20	5	1	4	0	0
ECTOR	28	92	38	10	125	22	219	26
EDWARDS	0	0	0	0	0	0	0	0
ELLIS	46	117	63	17	21	26	300	87
ERATH	4	31	2	1	8	2	2	15
FALLS	0	0	0	0	0	0	0	0
FANNIN	6	20	3	1	4	2	5	0
FAYETTE	2	14	3	1	15	4	1	0
FISHER	0	3	0	0	2	0	0	0
FOARD	0	0	0	0	0	0	0	0
FORT BEND	0	0	0	0	0	0	0	370
FRANKLIN	0	0	0	0	0	0	26	0
FREESTONE	0	8	0	0	1	1	0	0
FRIO	0	16	4	1	2	1	0	0
GALVESTON	0	0	0	0	0	0	0	426
GILLESPIE	8	6	13	3	7	2	5	155
GLASSCOCK	0	0	0	0	0	0	0	0
GOLIAD	0	4	0	0	0	1	0	0
GONZALES	0	4	1	0	2	1	0	7
GRAYSON	25	113	43	12	35	17	90	103
GRIMES	3	8	0	0	0	4	0	0
GUADALUPE	21	140	69	18	38	66	142	387
HALL	0	1	0	0	0	0	0	0
HAMILTON	0	6	0	0	4	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0
HARRIS	1,424	2,949	2,360	630	1,642	2,392	4,792	4,778
HASKELL	0	0	9	2	0	14	0	0
HAYS	75	219	121	32	59	137	65	405
HENDERSON	0	0	0	0	0	0	0	2
HIDALGO	0	0	0	0	0	0	0	943
HILL	4	49	7	2	3	1	0	0
HOOD	34	62	12	3	6	10	0	0
HOPKINS	5	17	10	3	5	2	12	3
HOUSTON	2	5	17	5	7	2	0	0
HOWARD	4	10	1	0	5	3	0	6
HUDSPETH	1	9	0	0	0	13	0	0
HUNT	17	80	14	4	13	18	11	15
IRION	0	0	0	0	0	0	0	0
JACK	1	1	0	0	0	17	0	0
JACKSON	1	16	1	0	0	0	0	0
JEFF DAVIS	6	0	0	0	0	2	0	0
JIM HOGG	0	8	0	0	1	10	0	0
JIM WELLS	0	47	22	6	23	7	4	3
JOHNSON	9	134	51	14	4	8	64	193
JONES	8	8	0	0	0	0	4	0
KARNES	0	7	0	0	1	5	0	0
KAUFMAN	20	118	28	8	5	15	79	194
KENDALL	0	0	0	0	0	0	0	9
KENEDY	0	0	0	0	0	1	0	0

[37] Source: Dodge/McGraw-Hill 2007

Table 28: 2009 New Commercial Building Construction (sq. ft. x 1000)[38]

Table shows Dodge (2005) data merged into PNNL building types (sq. ft. x 1000) (Part 3)

ERCOT Counties	Assembly	Education	Retail	Food	Lodging	Office	Warehouse	Stores and Restaurants
KENT	0	0	0	0	2	0	0	0
KERR	43	50	23	6	53	26	0	0
KIMBLE	2	0	0	0	0	2	0	0
KING	0	0	0	0	0	0	0	0
KINNEY	0	3	0	0	0	23	0	0
KLEBERG	6	38	33	9	8	6	1	160
KNOX	1	1	0	0	0	0	0	0
LA SALLE	0	1	0	0	2	0	0	0
LAMAR	4	29	5	1	2	5	2	10
LAMPASAS	2	9	12	3	7	4	0	2
LAVACA	7	2	0	0	1	2	0	0
LEE	1	13	1	0	0	5	0	12
LEON	7	7	0	0	0	0	0	0
LIMESTONE	3	5	9	2	4	9	0	0
LIVE OAK	10	0	0	0	0	0	0	0
LLANO	1	24	0	0	56	4	0	0
LOVING	0	0	0	0	0	0	0	0
MADISON	1	10	0	0	0	0	0	0
MARTIN	0	0	0	0	0	0	0	0
MASON	0	1	0	0	0	2	0	0
MATAGORDA	4	26	5	1	9	6	7	0
MAVERICK	13	41	12	3	28	24	1	30
MCCULLOCH	0	9	0	0	0	0	0	0
MCLENNAN	71	266	99	26	122	92	121	148
MCMULLEN	2	1	0	0	0	1	0	0
MEDINA	3	20	1	0	0	11	1	0
MENARD	0	1	0	0	0	0	0	0
MIDLAND	88	59	89	24	51	59	18	188
MILAM	3	39	10	3	0	19	0	100
MILLS	2	8	0	0	0	1	0	0
MITCHELL	4	0	0	0	5	14	0	0
MONTAGUE	1	13	10	3	6	5	1	100
MONTGOMERY	0	0	0	0	0	0	0	452
MOTLEY	0	1	0	0	0	0	0	0
NACOGDOCHES	22	117	19	5	27	14	13	0
NAVARRO	3	30	18	5	14	2	34	215
NOLAN	6	17	10	3	8	0	0	100
NUECES	0	0	0	0	0	0	0	103
PALO PINTO	4	26	15	4	3	2	2	203
PARKER	10	130	71	19	37	8	6	532
PECOS	3	6	0	0	9	11	0	0
PRESIDIO	3	5	0	0	0	1	0	0
RAINS	1	8	0	0	0	1	0	0
REAGAN	1	0	0	0	0	8	0	0
REAL	0	1	0	0	4	1	0	0
RED RIVER	2	14	0	0	0	0	0	0
REEVES	5	2	0	0	4	47	0	5
REFUGIO	1	1	0	0	0	2	0	0
ROBERTSON	1	3	0	0	1	0	1	0
ROCKWALL	26	158	95	25	15	26	36	152
RUNNELS	0	6	1	0	0	2	0	0
RUSK	1	6	11	3	1	2	2	140
SAN PATRICIO	13	56	23	6	19	75	241	161
SAN SABA	4	3	1	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0
SCURRY	1	0	4	1	2	1	12	0
SHACKELFORD	2	4	0	0	2	0	0	0
SMITH	80	113	87	23	120	121	147	64
SOMERVELL	0	7	0	0	1	5	1	0
STARR	0	0	0	0	0	0	0	0
STEPHENS	0	6	0	0	1	0	0	0
STERLING	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0
SUTTON	0	2	0	0	1	1	0	0
TARRANT	737	1,564	1,667	445	1,003	902	1,875	2,836
TAYLOR	34	49	80	21	60	32	52	384
TERRELL	0	0	0	0	0	6	0	0
THROCKMORTON	1	0	0	0	0	1	0	0
TITUS	4	26	7	2	0	2	0	0
TOM GREEN	61	89	52	14	112	40	33	158
TRAVIS	315	525	646	172	652	527	398	1,436
UPTON	0	0	0	0	0	0	0	0
UVALDE	14	32	33	9	5	7	8	236
VAL VERDE	9	29	7	2	9	27	3	5
VAN ZANDT	1	41	0	0	0	1	0	0
VICTORIA	0	0	0	0	0	0	0	15
WALLER	3	12	0	0	0	0	14	22
WARD	0	0	0	0	0	7	0	0
WASHINGTON	30	36	33	9	12	13	25	253
WEBB	28	275	53	14	95	78	118	33
WHARTON	9	16	30	8	6	6	11	29
WICHITA	59	50	51	13	165	57	28	103
WILBARGER	3	7	9	2	11	17	1	0
WILLACY	2	42	27	7	1	26	7	4
WILLIAMSON	116	399	305	81	123	134	119	946
WILSON	0	0	0	0	0	0	0	74
WINKLER	1	0	0	0	0	0	0	0
WISE	18	73	1	0	47	19	0	0
YOUNG	10	21	23	6	6	4	2	0
ZAPATA	2	40	1	0	1	12	0	0
ZAVALA	0	5	0	0	1	1	0	0
TOTAL (ERCOT COUNTIES)	5,290	13,900	9,756	2,603	7,815	7,821	11,452	26,415

[38] Source: Dodge/McGraw-Hill 2007

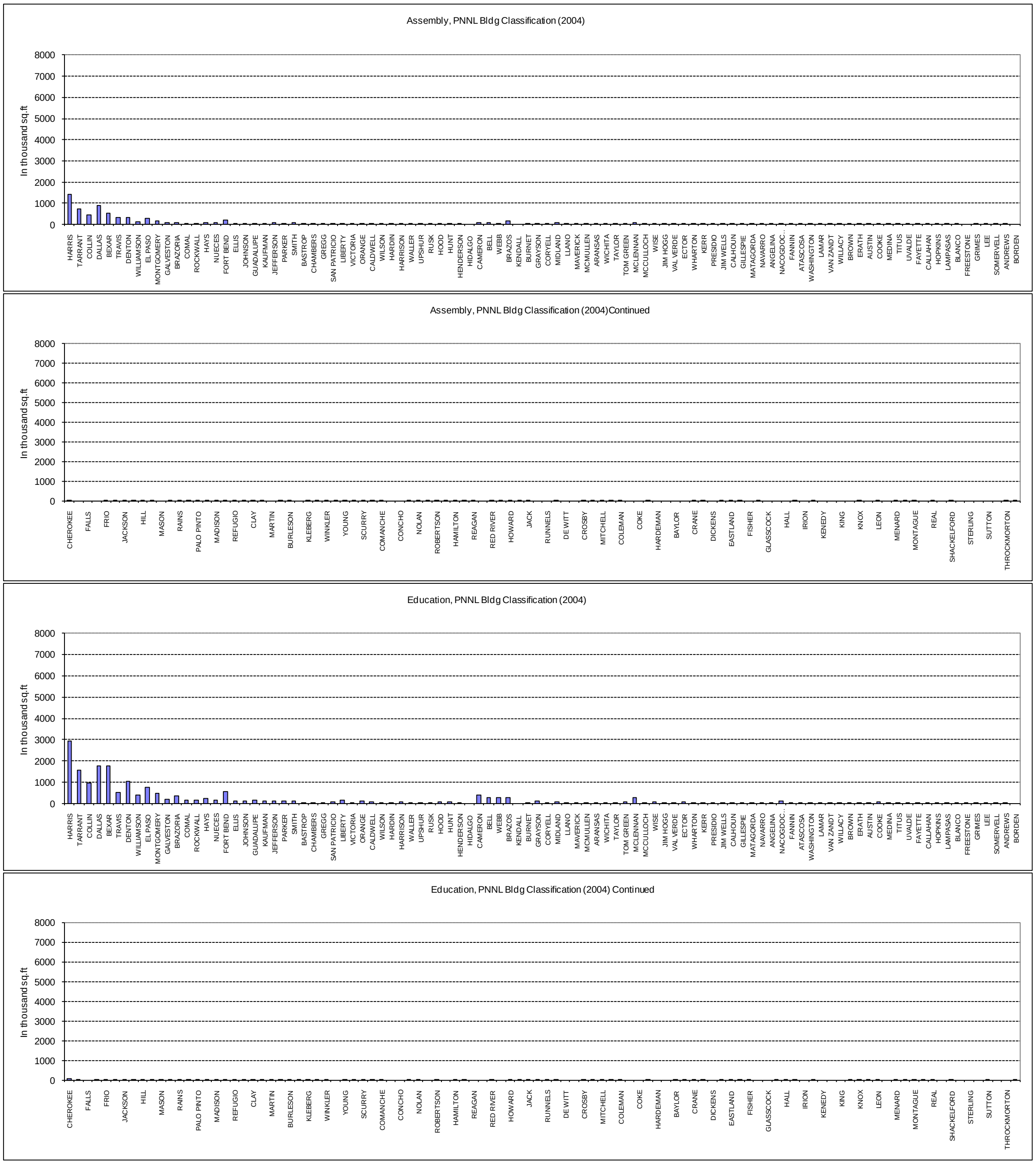


Figure 80: 2009 New Commercial Building Construction (sq. ft. x 1000), Part 1 (Dodge 2007)

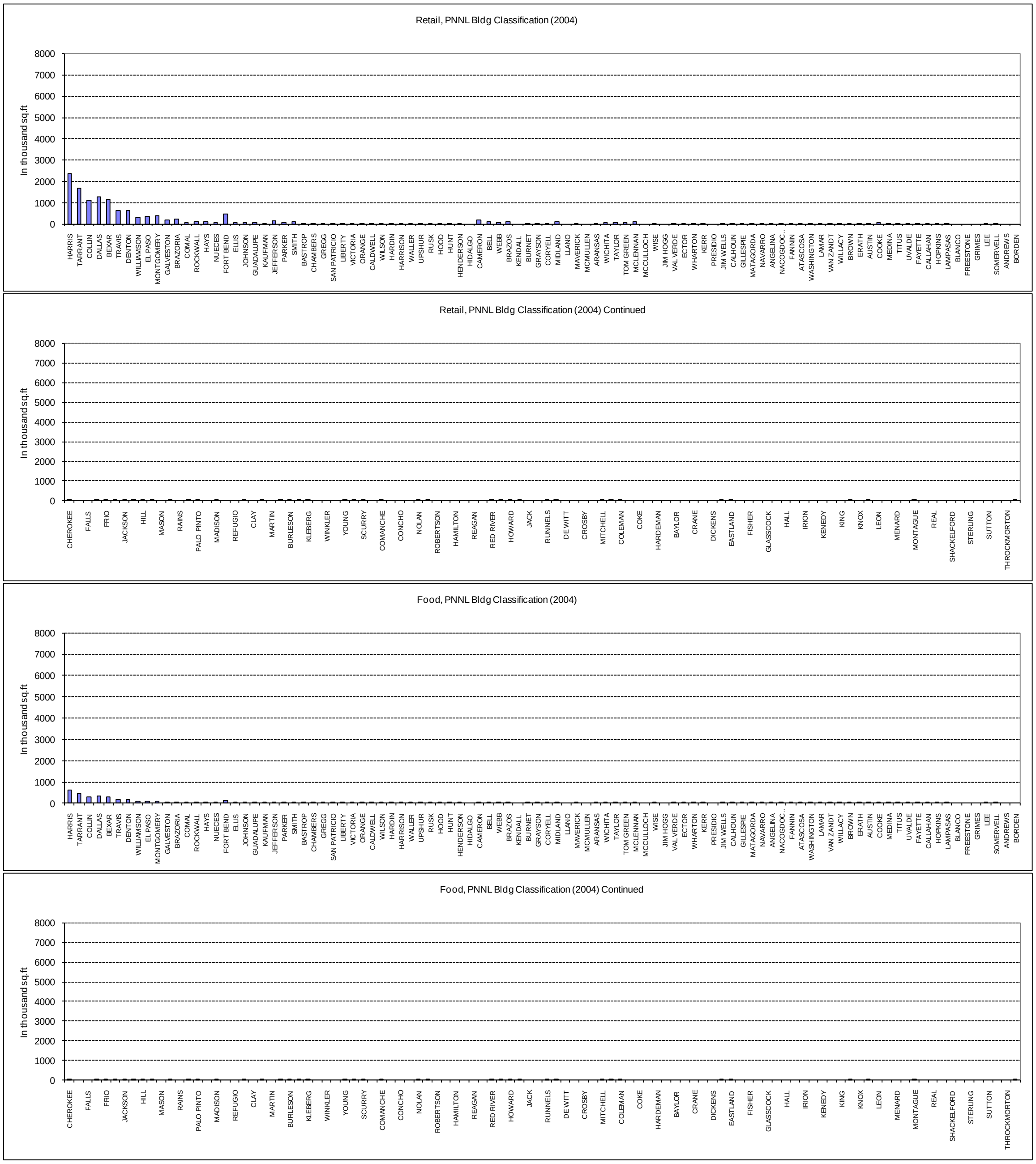


Figure 81: 2009 New Commercial Building Construction (sq. ft. x 1000), Part 2 (Dodge 2007)

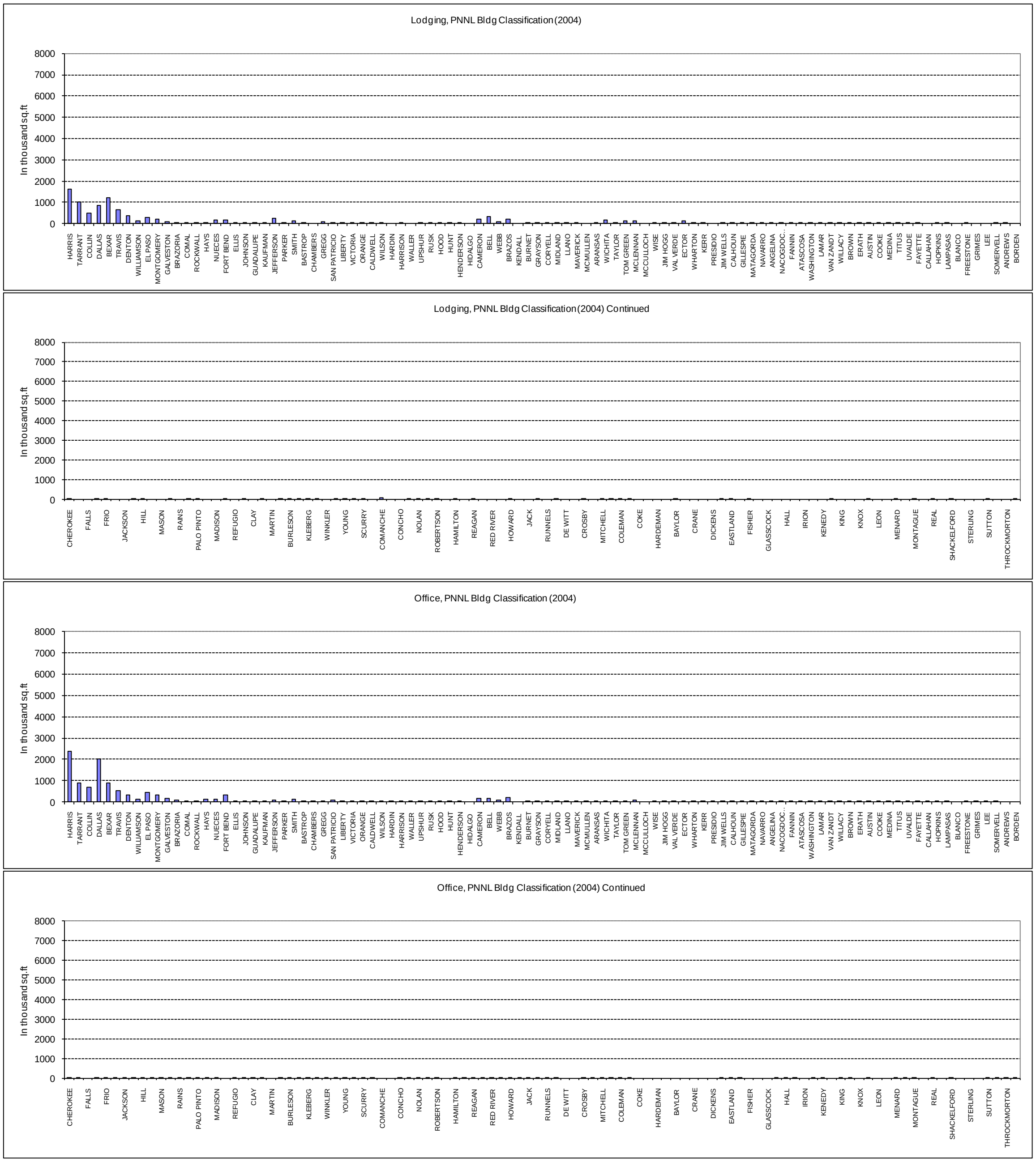


Figure 82: 2009 New Commercial Building Construction (sq. ft. x 1000), Part 3 (Dodge 2007)

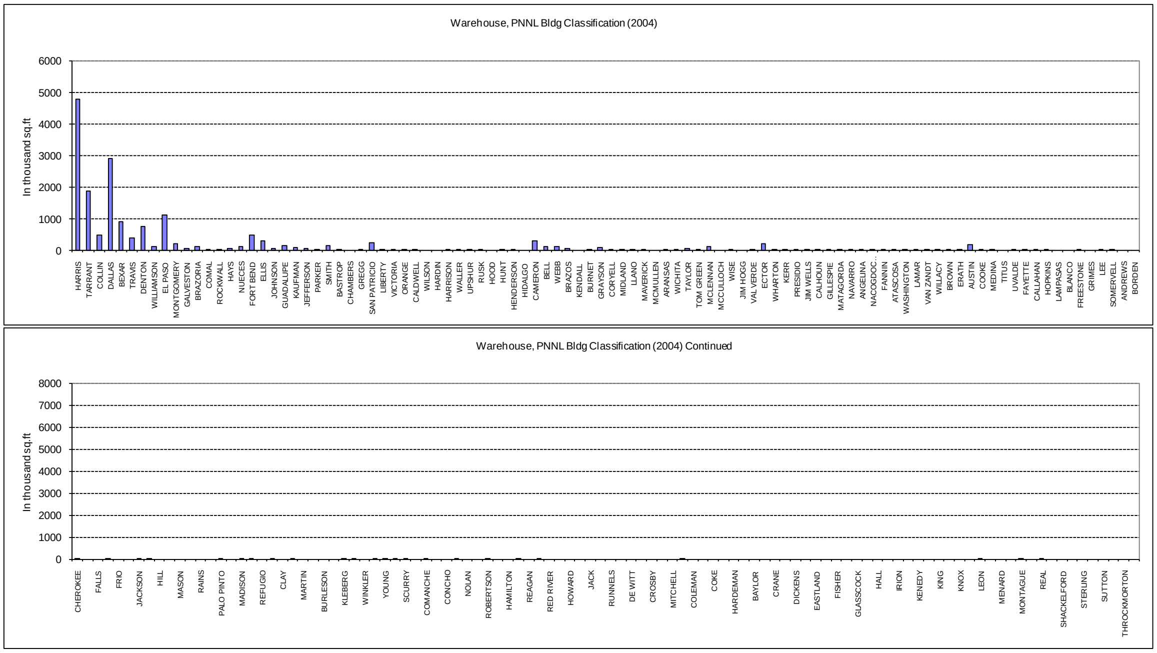


Figure 83: 2009 New Commercial Building Construction (sq. ft. x 1000), Part 4 (Dodge 2007)

Table 29: Calculated ASHRAE Standard 90.1-1989 and 1999 Energy Use for Assembly, Education, and Retail Building Types (USEDOE 2004) (Part 1)

Assembly

Non-attainment Counties	In thousand	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
		1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
Brazoria	94	1676521	5640.9	1517449	4828	3019	5	3178	2
Chambers	7	121565	409.0	110031	350	219	0	230	0
Collin	459	8211993	27630.3	7432821	23650	14786	23	15567	10
Dallas	909	16249127	54672.3	14707374	46797	29257	45	30803	19
Denton	327	5848082	19676.6	5293203	16842	10530	16	11086	7
El Paso	295	5266305	17719.2	4766627	15167	9482	15	9983	6
Fort Bend	211	3763926	12664.2	3406796	10840	6777	10	7135	4
Galveston	84	1500463	5048.5	1358096	4321	2702	4	2844	2
Hardin	6	111361	374.7	100795	321	201	0	211	0
Harris	1424	25443486	85607.9	23029352	73277	45812	71	48232	30
Jefferson	88	1576170	5303.2	1426619	4539	2838	4	2988	2
Liberty	5	83894	282.3	75934	242	151	0	159	0
Montgomery	176	3142465	10573.2	2844301	9050	5658	9	5957	4
Orange	11	198199	666.9	179393	571	357	1	376	0
Tarrant	737	13173191	44322.9	11923290	37939	23719	37	24972	15
Waller	3	55885	188.0	50582	161	101	0	106	0
Total (Non-attainment)	4836	86422633	290780	78222663	248896	155608	240	163829	101

Education

Non-attainment Counties	In thousand	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
		1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
Brazoria	366	3785990	12738	3354823	10675	6898	11	7333	5
Chambers	33	346585	1166	307114	977	631	1	671	0
Collin	974	10083496	33927	8935137	28431	18371	28	19530	12
Dallas	1769	18307345	61597	16222414	51618	33354	51	35459	22
Denton	1041	10777562	36263	9550160	30388	19636	30	20875	13
El Paso	746	7724164	25989	6844497	21778	14073	22	14961	9
Fort Bend	546	5646948	19000	5003845	15922	10288	16	10937	7
Galveston	197	2038584	6859	1806420	5748	3714	6	3948	2
Hardin	38	394860	1329	349892	1113	719	1	765	0
Harris	2949	30530802	102725	27053802	86082	55625	86	59134	37
Jefferson	117	1215416	4089	1076998	3427	2214	3	2354	1
Liberty	171	1765150	5939	1564126	4977	3216	5	3419	2
Montgomery	477	4933359	16599	4371523	13910	8988	14	9555	6
Orange	107	1102776	3710	977187	3109	2009	3	2136	1
Tarrant	1564	16186680	54462	14343260	45639	29491	45	31352	19
Waller	12	121569	409	107724	343	221	0	235	0
Total (Non-attainment)	11106	114961287	386802	101868922	324135	209450	322	222666	138

Retail

Non-attainment Counties	In thousand	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
		1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
Brazoria	237	3936500	13245	3316470	10553	937	1	1227	1
Chambers	5	85951	289	72413	230	20	0	27	0
Collin	1131	18764361	63135	15808827	50302	4467	7	5847	4
Dallas	1283	21286842	71622	17933997	57064	5068	8	6633	4
Denton	621	10304989	34672	8681872	27625	2453	4	3211	2
El Paso	343	5693033	19155	4796336	15261	1355	2	1774	1
Fort Bend	454	7539432	25367	6351912	20211	1795	3	2349	1
Galveston	173	2868610	9652	2416781	7690	683	1	894	1
Hardin	13	217605	732	183331	583	52	0	68	0
Harris	2360	39158503	131754	32990731	104973	9322	14	12202	8
Jefferson	165	2739476	9217	2307987	7344	652	1	854	1
Liberty	13	216065	727	182033	579	51	0	67	0
Montgomery	408	6769525	22777	5703271	18147	1612	2	2109	1
Orange	17	290106	976	244412	778	69	0	90	0
Tarrant	1667	27652878	93042	23297332	74129	6583	10	8617	5
Waller	0	8266	28	6964	22	2	0	3	0
Total (Non-attainment)	8892	147532142	496391	124294667	395491	35123	54	45971	28

Assembly

Affected Counties	In thousand	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
		1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
Bastrop	5	97542	328.2	88287	281	176	0	185	0
Bexar	532	9511289	32002.0	8608837	27392	17126	26	18030	11
Caldwell	2	37358	125.7	33813	108	67	0	71	0
Comal	25	444257	1494.8	402105	1279	800	1	842	1
Ellis	46	818987	2755.6	741280	2359	1475	2	1553	1
Gregg	48	859056	2890.4	777547	2474	1547	2	1628	1
Guadalupe	21	372804	1254.3	337431	1074	671	1	707	0
Harrison	39	704949	2371.9	638062	2030	1269	2	1336	1
Hays	75	1333807	4487.8	1207252	3841	2402	4	2528	2
Henderson	4	75569	254.3	68399	218	136	0	143	0
Hood	34	609755	2051.6	551901	1756	1098	2	1156	1
Hunt	17	295412	994.0	267383	851	532	1	560	0
Johnson	9	168450	566.8	152467	485	303	0	319	0
Kaufman	20	351861	1183.9	318475	1013	634	1	667	0
Nueces	102	1814053	6103.6	1641932	5224	3266	5	3439	2
Parker	10	170394	573.3	154227	491	307	0	323	0
Rockwall	26	472358	1589.3	427540	1360	851	1	895	1
Rusk	1	10290	34.6	9314	30	19	0	20	0
San Patricio	13	237634	799.6	215087	684	428	1	450	0
Smith	80	1423915	4790.9	1288811	4101	2564	4	2699	2
Travis	315	5624194	18923.3	5090558	16198	10127	16	10662	7
Upshur	11	194637	654.9	176170	561	350	1	369	0
Victoria	17	303662	1021.7	274850	875	547	1	576	0
Williamson	116	2080761	7001.0	1883333	5993	3747	6	3944	2
Wilson	2	40072	134.8	36270	115	72	0	76	0
Total (Affected)	1570	28053066	94388	25391329	80792	50511	78	53179	33

Education

Affected Counties	In thousand	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
		1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
Bastrop	53	547404	1842	485063	1543	997	2	1060	1
Bexar	1781	18434651	62026	16335221	51977	33586	52	35706	22
Caldwell	60	616464	2074	546258	1738	1123	2	1194	1
Comal	145	1495954	5033	1325587	4218	2726	4	2897	2
Ellis	117	1208903	4068	1071227	3409	2203	3	2341	1
Gregg	33	346554	1166	307087	977	631	1	671	0
Guadalupe	140	1453668	4891	1288117	4099	2648	4	2816	2
Harrison	61	632144	2127	560152	1782	1152	2	1224	1
Hays	219	2263435	7616	2005664	6382	4124	6	4384	3
Henderson	21	218288	734	193429	615	398	1	423	0
Hood	62	640323	2154	567400	1805	1167	2	1240	1
Hunt	80	828602	2788	734237	2336	1510	2	1605	1
Johnson	134	1384855	4660	1227141	3905	2523	4	2682	2
Kaufman	118	1225788	4124	1086189	3456	2233	3	2374	1
Nueces	150	1557085	5239	1379756	4390	2837	4	3016	2
Parker	130	1346966	4532	1193567	3798	2454	4	2609	2
Rockwall	158	1632628	5493	1446696	4603	2975	5	3162	2
Rusk	6	63102	212	55916	178	115	0	122	0
San Patricio	56	583636	1964	517168	1646	1063	2	1130	1
Smith	113	1174684	3952	1040906	3312	2140	3	2275	1
Travis	525	5430906	18273	4812407	15313	9895	15	10519	6
Upshur	29	298730	1005	264709	842	544	1	579	0
Victoria	16	167296	563	148243	472	305	0	324	0
Williamson	399	4130519	13898	3660115	11646	7525	12	8000	5
Wilson	24	248006	834	219762	699	452	1	480	0
Total (Affected)	4630	47930590	161269	42472015	135141	87326	134	92836	57

Retail

Affected Counties	In thousand	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
		1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
Bastrop	16	268439	903	226157	720	64	0	84	0
Bexar	1141	18937531	63718	15954721	50766	4508	7	5901	4
Caldwell	12	200847	676	169212	538	48	0	63	0
Comal	71	1179079	3967	993364	3161	281	0	367	0
Ellis	63	1041359	3504	877337	2792	248	0	324	0
Gregg	45	743451	2501	626352	1993	177	0	232	0
Guadalupe	69	1147425	3861	966697	3076	273	0	358	0
Harrison	32	532576	1792	448691	1428	127	0	166	0
Hays	121	2003494	6741	1687928	5371	477	1	624	0
Henderson	9	147716	497	124449	396	35	0	46	0
Hood	12	206282	694	173791	553	49	0	64	0
Hunt	14	231671	779	195181	621	55	0	72	0
Johnson	51	848104	2854	714521	2274	202	0	264	0
Kaufman	28	472862	1591	398383	1268	113	0	147	0
Nueces	70	1161107	3907	978224	3113	276	0	362	0
Parker	71	1170704	3939	986309	3138	279	0	365	0
Rockwall	95	1582511	5325	1333253	4242	377	1	493	0
Rusk	11	177507	597	149548	476	42	0	55	0
San Patricio	23	378735	1274	319082	1015	90	0	118	0
Smith	87	1441125	4849	1214136	3863	343	1	449	0
Travis	646	10715898	36055	9028059	28726	2551	4	3339	2
Upshur	4	62400	210	52572	167	15	0	19	0
Victoria	29	485664	1634	409168	1302	116	0	151	0
Williamson	305	5062247	17033	4264903	13570	1205	2	1577	1
Wilson	5	77288	260	65114	207	18	0	24	0
Total (Affected)	3030	50276024	169160	42357154	134776	11969	18	15666	10

Table 30: Calculated ASHRAE Standard 90.1-1989 and 1999 Energy Use for Assembly, Education, and Retail Building Types (USDOE 2004) (Part 2)

Assembly

ERCOT Counties	In thousand	Electricity (kWh/yr), PNNL 1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	Gas (mBtu/yr), PNNL 1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
ANDERSON	1	22657	76.2	20507	65	41	0	43	0
ANDREWS	1	11949	40.2	10815	34	22	0	23	0
ANGELINA	33	596317	2006.4	539737	1717	1074	2	1130	1
ARANSAS	4	71112	239.3	64365	205	128	0	135	0
ARCHER	1	22097	74.3	20000	64	40	0	42	0
ATASCOSA	11	203235	683.8	183952	585	366	1	385	0
AUSTIN	1	9965	33.5	9019	29	18	0	19	0
BANDERA	0	0	0.0	0	0	0	0	0	0
Bastrop	0	0	0.0	0	0	0	0	0	0
BAYLOR	0	0	0.0	0	0	0	0	0	0
BEE	19	340565	1145.9	308251	981	613	1	646	0
BELL	78	1389922	4676.6	1258043	4003	2503	4	2635	2
Bexar	532	9511289	32002.0	8608837	27392	17126	26	18030	11
BLANCO	0	2511	8.4	2273	7	5	0	5	0
BORDEN	0	0	0.0	0	0	0	0	0	0
BOSQUE	1	16718	56.2	15132	48	30	0	32	0
Brazoria	94	1676521	5640.9	1517449	4828	3019	5	3178	2
BRAZOS	150	2675710	9002.8	2421833	7706	4818	7	5072	3
BREWSTER	4	78573	264.4	71118	226	141	0	149	0
BRISCOE	0	0	0.0	0	0	0	0	0	0
BROOKS	0	3191	10.7	2889	9	6	0	6	0
BROWN	5	97218	327.1	87994	280	175	0	184	0
BURLESON	1	20479	68.9	18536	59	37	0	39	0
BURNET	7	120960	407.0	109483	348	218	0	229	0
Caldwell	0	0	0.0	0	0	0	0	0	0
CALHOUN	0	797	2.7	721	2	1	0	2	0
CALLAHAN	3	50151	168.7	45393	144	90	0	95	0
CAMERON	80	1429686	4810.4	1294034	4117	2574	4	2710	2
Chambers	7	121565	409.0	110031	350	219	0	230	0
CHEROKEE	37	654229	2201.2	592154	1884	1178	2	1240	1
CHILDRESS	0	0	0.0	0	0	0	0	0	0
CLAY	0	6687	22.5	6053	19	12	0	13	0
COKE	0	0	0.0	0	0	0	0	0	0
COLEMAN	1	15629	52.6	14146	45	28	0	30	0
Collin	459	8211993	27630.3	7432821	23650	14786	23	15567	10
COLORADO	0	0	0.0	0	0	0	0	0	0
Comal	25	444257	1494.8	402105	1279	800	1	842	1
COMANCHE	7	124622	419.3	112798	359	224	0	236	0
CONCHO	0	0	0.0	0	0	0	0	0	0
COOKE	21	384248	1292.9	347789	1107	692	1	728	0
CORYELL	13	233140	784.4	211019	671	420	1	442	0
COTTLE	0	0	0.0	0	0	0	0	0	0
CRANE	1	26794	90.2	24252	77	48	0	51	0
CROCKETT	3	53522	180.1	48444	154	96	0	101	0
CROSBY	1	12762	42.9	11552	37	23	0	24	0
CULBERSON	1	12158	40.9	11005	35	22	0	23	0
Dallas	0	0	0.0	0	0	0	0	0	0
DAWSON	0	7110	23.9	6435	20	13	0	13	0
DE WITT	0	0	0.0	0	0	0	0	0	0
DELTA	0	4103	13.8	3714	12	7	0	8	0
Denton	0	0	0.0	0	0	0	0	0	0
DICKENS	0	0	0.0	0	0	0	0	0	0
DIMMIT	0	0	0.0	0	0	0	0	0	0
DUVAL	0	3799	12.8	3439	11	7	0	7	0
EASTLAND	7	127633	429.4	115523	368	230	0	242	0
ECTOR	28	496586	1670.8	449469	1430	894	1	941	1
EDWARDS	0	2736	9.2	2476	8	5	0	5	0
Ellis	46	818987	2755.6	741280	2359	1475	2	1553	1
ERATH	4	75155	252.9	68024	216	135	0	142	0
FALLS	0	0	0.0	0	0	0	0	0	0
FANNIN	6	101053	340.0	91465	291	182	0	192	0
FAYETTE	2	37593	126.5	34026	108	68	0	71	0
FISHER	0	0	0.0	0	0	0	0	0	0
FOARD	0	3169	10.7	2869	9	6	0	6	0
Fort Bend	0	0	0.0	0	0	0	0	0	0
FRANKLIN	0	6927	23.3	6270	20	12	0	13	0
FREESTONE	0	0	0.0	0	0	0	0	0	0
FRIO	0	8931	30.0	8083	26	16	0	17	0
Galveston	0	0	0.0	0	0	0	0	0	0
GILLESPIE	8	134757	453.4	121971	388	243	0	255	0
GLASSCOCK	0	0	0.0	0	0	0	0	0	0
GOLIAD	0	0	0.0	0	0	0	0	0	0
GONZALES	0	8812	29.6	7975	25	16	0	17	0
GRAYSON	25	454792	1530.2	411640	1310	819	1	862	1
GRIMES	3	53156	178.9	48113	153	96	0	101	0
Guadalupe	21	372804	1254.3	337431	1074	671	1	707	0
HALL	0	0	0.0	0	0	0	0	0	0
HAMILTON	0	6079	20.5	5502	18	11	0	12	0
HARDEMAN	0	0	0.0	0	0	0	0	0	0
Harris	1424	25443486	85607.9	23029352	73277	45812	71	48232	30
HASKELL	0	3040	10.2	2751	9	5	0	6	0
Hays	75	1333807	4487.8	1207252	3841	2402	4	2528	2
Henderson	0	0	0.0	0	0	0	0	0	0
HIDALGO	0	0	0.0	0	0	0	0	0	0
HILL	4	74779	251.6	67684	215	135	0	142	0
Hood	34	609755	2051.6	551901	1756	1098	2	1156	1
HOPKINS	5	89866	302.4	81339	259	162	0	170	0
HOUSTON	2	32935	110.8	29811	95	59	0	62	0
HOWARD	4	74809	251.7	67711	215	135	0	142	0
HUDSPETH	1	11622	39.1	10520	33	21	0	22	0
Hunt	17	295412	994.0	267383	851	532	1	560	0

Education

ERCOT Counties	In thousand	Electricity (kWh/yr), PNNL 1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	Gas (mBtu/yr), PNNL 1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
ANDERSON	1	10260	35	9092	29	19	0	20	0
ANDREWS	6	58202	196	51573	164	106	0	113	0
ANGELINA	53	548779	1846	486282	1547	1000	2	1063	1
ARANSAS	1	14463	49	12816	41	26	0	28	0
ARCHER	17	177212	596	157031	500	323	0	343	0
ATASCOSA	21	217377	731	192621	613	396	1	421	0
AUSTIN	38	390934	1315	346412	1102	712	1	757	0
BANDERA	0	0	0	0	0	0	0	0	0
Bastrop	0	0	0	0	0	0	0	0	0
BAYLOR	1	13545	46	12002	38	25	0	26	0
BEE	49	505963	1702	448341	1427	922	1	980	1
BELL	257	2664897	8966	2361405	7514	4855	7	5162	3
Bexar	1781	18434651	62026	16335221	51977	33586	52	35706	22
BLANCO	18	182545	614	161756	515	333	1	354	0
BORDEN	0	0	0	0	0	0	0	0	0
BOSQUE	16	166996	562	147978	471	304	0	323	0
Brazoria	366	3785990	12738	3354823	10675	6898	11	7333	5
BRAZOS	293	3032776	10204	2687388	8551	5525	9	5874	4
BREWSTER	11	110667	372	98063	312	202	0	214	0
BRISCOE	0	0	0	0	0	0	0	0	0
BROOKS	0	0	0	0	0	0	0	0	0
BROWN	15	153228	516	135777	432	279	0	297	0
BURLESON	12	122631	413	108665	346	223	0	238	0
BURNET	51	528463	1778	468279	1490	963	1	1024	1
Caldwell	0	0	0	0	0	0	0	0	0
CALHOUN	11	114579	386	101530	323	209	0	222	0
CALLAHAN	18	181279	610	160634	511	330	1	351	0
CAMERON	390	4036917	13583	3577172	11382	7355	11	7819	5
Chambers	33	346585	1166	307114	977	631	1	671	0
CHEROKEE	56	579037	1948	513094	1633	1055	2	1122	1
CHILDRESS	0	0	0	0	0	0	0	0	0
CLAY	3	34255	115	30354	97	62	0	66	0
COKE	0	0	0	0	0	0	0	0	0
COLEMAN	1	15299	51	13557	43	28	0	30	0
Collin	974	10083496	33927	8935137	28431	18371	28	19530	12
COLORADO	17	175440	590	155460	495	320	0	340	0
Comal	145	1495954	5033	1325587	4218	2726	4	2897	2
COMANCHE	36	376215	1266	333370	1061	685	1	729	0
CONCHO	0	0	0	0	0	0	0	0	0
COOKE	76	788052	2652	698305	2222	1436	2	1526	1
CORYELL	35	360748	1214	319664	1017	657	1	699	0
COTTLE	2	15771	53	13975	44	29	0	31	0
CRANE	1	15042	51	13329	42	27	0	29	0
CROCKETT	2	16699	56	14797	47	30	0	32	0
CROSBY	0	2227	7	1973	6	4	0	4	0
CULBERSON	8	86206	290	76388	243	157	0	167	0
Dallas	0	0	0	0	0	0	0	0	0
DAWSON	7	69580	234	61656	196	127	0	135	0
DE WITT	0	0	0	0	0	0	0	0	0
DELTA	3	27275	92	24169	77	50	0	53	0
Denton	0	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0	0
DIMMIT	3	27056	91	23975	76	49	0	52	0
DUVAL	20	211498	712	187412	596	385	1	410	0
EASTLAND	4	38973	131	34535	110	71	0	75	0
ECTOR	92	956241	3217	847339	2696	1742	3	1852	1
EDWARDS	0	4824	16	4275	14	9	0	9	0
Ellis	117	1208903	4068	1071227	3409	2203	3	2341	1
ERATH	31	320569	1079	284061	904	584	1	621	0
FALLS	0	0	0	0	0	0	0	0	0
FANNIN	20	211108	710	187066	595	385	1	409	0
FAYETTE	14	145633	490	129048	411	265	0	282	0
FISHER	3	35161	118	31157	99	64	0	68	0
FOARD	0	0	0	0	0	0	0	0	0
Fort Bend	0	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0	0
FREESTONE	8	85916	289	76132	242	157	0	166	0
FRIO	16	160971	542	142639	454	293	0	312	0
Galveston	0	0	0	0	0	0	0	0	0
GILLESPIE	6	57087	192	50585	161	104	0	111	0
GLASSCOCK	0	0	0	0	0	0	0	0	0
GOLIAD	4	45234	152	40083	128	82	0	88	0
GONZALES	4	40649	137	36019	115	74	0	79	0
GRAYSON	113	1167263	3927	1034329	3291	2127	3	2261	1
GRIMES	8	78902	265	69916	222	144	0	153	0
Guadalupe	140	1453668	4891	1288117	4099	2648	4	2816	2
HALL	1	5566	19	4933	16	10	0	11	0
HAMILTON	6	60442	203	53558	170	110	0	117	0
HARDEMAN	0	0	0	0	0	0	0	0	0
Harris	2949	30530802	102725	27053802	86082	55625	86	59134	37
HASKELL	0	0	0	0	0	0	0	0	0
Hays	219	2263435	7616	2005664	6382	4124	6	4384	3
Henderson	0	0	0	0	0	0	0	0	0
HIDALGO	0	0	0	0	0	0	0	0	0
HILL	49	509749	1715	451696	1437	929	1	987	1
Hood	62	640323	2154	567400	1805	1167	2	1240	1
HOPKINS	17	171905	578	152328	485	313	0	333	0
HOUSTON	5	56468	190	50037	159	103	0	109	0
HOWARD	10	104544	352	92638	295	190	0	202	0
HUDSPETH	9	89856	302	79623	253	164	0	174	0
Hunt	80	828602	2788	734237	2336	1510	2	1605	1

Retail

ERCOT Counties	In thousand	Electricity (kWh/yr), PNNL 1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	Gas (mBtu/yr), PNNL 1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
ANDERSON	2	33980	114	28628	91	8	0	11	0
ANDREWS	0	0	0	0	0	0	0	0	0
ANGELINA	45	753098	2534	634480	2019	179	0	235	0
ARANSAS	26	438058	1474	369060	1174	104	0	136	0
ARCHER	0	0	0	0	0	0	0	0	0
ATASCOSA	11	187293	630	157793	502	45	0	58	0
AUSTIN	1	12949	44	10909	35	3	0	4	0
BANDERA	0	0	0	0	0	0	0	0	0
Bastrop	0	0	0	0	0	0	0	0	0
BAYLOR	0	0	0	0	0	0	0	0	0
BEE	5	91052	306	76711	244	22	0	28	0
BELL	88	1458600	4908	1228859	3910	347	1	454	0
Bexar	1141	18937531	63718	15954721	50766	4508	7	5901	4
BLANCO	0	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0	0
Brazoria	237	3936500	13245	3316470	10553	937	1	1227	1
BRAZOS	106	1753685	5901	1477465	4701	417	1	546	0
BREWSTER	0	0	0	0	0	0	0	0	0
BRISCOE	0	0	0	0	0	0	0	0	0
BROOKS	0	7877	27	6636	21	2	0	2	0
BROWN	8	128186	431	107996	344	31	0	40	0
BURLESON	1	8495	29	7157	23	2	0	3	0
BURNET	10	168145	566	141661	451	40	0	52	0
Caldwell	0	0	0	0	0	0	0	0	0
CALHOUN	18	302450	1018	254812	811	72	0	94	0
CALLAHAN	0	4016	14	3383	11	1	0	1	0
CAMERON	169	2797914	9414	2357221	7500	666	1	872	1
Chambers	5	85951	289	72413	230	20	0	27	0
CHEROKEE	10	160208	539	134974	429	38	0	50	0
CHILDRESS	0	0	0	0	0	0	0	0	0
CLAY	0	0	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0	0	0
COLEMAN	0	2433	8	2050	7	1	0	1	0
Collin	1131	18764361	63135	15808827	50302	4467	7	5847	4
COLORADO	0	3736	13	3147	10	1	0	1	0
Comal	71	1179079	3967	993364	3161	281	0	367	0
COMANCHE	1	17608	59	14834	47	4	0	5	0
CONCHO	0	0	0	0	0	0	0	0	0
COOKE	50	831672	2798	700677	2229	198	0	259	0
CORYELL	19	316953	1066	267031	850	75	0	99	0
COTTLE	0	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0	0
CROCKETT	0	0	0	0	0	0	0	0	0
CROSBY	0	0	0	0	0	0	0	0	0
CULBERSON	0	6178	21	5205	17	1	0	2	0
Dallas	0	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0	0
DE WITT	0	0	0	0	0	0	0	0	0
DELTA	0	0	0	0	0	0	0	0	0
Denton	0	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0	0
DIMMIT	0	0	0	0	0	0	0	0	0
DUVAL	1	13038	44	10985	35	3	0	4	0
EASTLAND	20	328893	1107	277090	882	78	0	102	0
ECTOR	38	632430	2128	532817	1695	151	0	197	0
EDWARDS	0	0	0	0	0	0	0	0	0
Ellis	63	1041359	3504	877337	2792	248	0	324	0
ERATH	2	39999	135	33699	107	10	0	12	0
FALLS	0	0	0	0	0	0	0	0	0
FANNIN	3	51090	172	43043	137	12	0	16	0
FAYETTE	3	47377	159	39915	127	11	0	15	0
FISHER	0	0	0	0	0	0	0	0	0
FOARD	0	0	0	0	0	0	0	0	0
Fort Bend	0	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0	0
FREESTONE	0	0	0	0	0	0	0	0	0
FRIO	4	62766	211	52879	168	15	0	20	0
Galveston	0	0	0	0	0	0	0	0	0
GILLESPIE	13	208982	703	176066	560	50	0	65	0
GLASSCOCK	0	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0	0
GONZALES	1	14678	49	12366	39	3	0	5	0
GRAYSON	43	720274	2423	606825	1931	171	0	224	0
GRIMES	0	0	0	0	0	0	0	0	0
Guadalupe	69	1147425	3861	966697	3076	273	0	358	0
HALL	0	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0	0
Harris	2360	39158503	131754	32990731	104973	9322	14	12202	8
HASKELL	9	142865	481	120362	383	34	0	45	0
Hays	121	2003494	6741	1687928	5371	477	1	624	0
Henderson	0	0	0	0	0	0	0	0	0
HIDALGO	0	0	0	0	0	0	0	0	0
HILL	7	115486	389	97296	310	27	0	36	0
Hood	12	206282	694	173791	553	49	0	64	0
HOPKINS	10	169246	569	142588	454	40	0	53	0
HOUSTON	17	287444	967	242169	771	68	0	90	0
HOWARD	1	18200	61	15333	49	4	0	6	0
HUDSPETH	0	0	0	0	0	0	0	0	0
Hunt	14	231671	779	195181	621	55	0	72	0

Table 31: Calculated ASHRAE Standard 90.1-1989 and 1999 Energy Use for Assembly, Education, and Retail Building Types (USDOE 2004) (Part 3)

ERCOT Counties	Assembly									Education									Retail								
	In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL				In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL				In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
JIM WELLS	0	3828	12.9	3465	11	7	0	7	0	47	489688	1648	433919	1381	892	1	948	1	22	357686	1203	301348	959	85	0	111	0
Johnson	9	168450	566.8	152467	485	303	0	319	0	134	1384855	4660	1227141	3905	2523	4	2682	2	51	848104	2854	714521	2274	202	0	264	0
JONES	8	144631	486.6	130908	417	260	0	274	0	8	87407	294	77452	246	159	0	169	0	0	0	0	0	0	0	0	0	0
KARNES	0	0	0.0	0	0	0	0	0	0	7	69397	233	61494	196	126	0	134	0	0	1843	6	1553	5	0	0	1	0
Kaufman	20	351861	1183.9	318475	1013	634	1	667	0	118	1225788	4124	1086189	3456	2233	3	2374	1	28	472862	1591	398383	1268	113	0	147	0
KENDALL	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENEDY	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENT	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KERR	43	759912	2556.8	687810	2189	1368	2	1441	1	50	513000	1726	454577	1446	935	1	994	1	23	374653	1261	315642	1004	89	0	117	0
KIMBLE	2	28876	97.2	26136	83	52	0	55	0	0	2783	9	2466	8	5	0	5	0	0	0	0	0	0	0	0	0	0
KING	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KINNEY	0	0	0.0	0	0	0	0	0	0	3	31830	107	28205	90	58	0	62	0	0	7334	25	6179	20	2	0	2	0
KLEBERG	6	104819	352.7	94874	302	189	0	199	0	38	393893	1325	349035	1111	718	1	763	0	33	540651	1819	455495	1449	129	0	168	0
KNOX	1	15198	51.1	13756	44	27	0	29	0	1	12988	44	11509	37	24	0	25	0	0	0	0	0	0	0	0	0	0
LA SALLE	0	0	0.0	0	0	0	0	0	0	1	12865	43	11400	36	23	0	25	0	0	6642	22	5595	18	2	0	2	0
LAMAR	4	71970	242.2	65142	207	130	0	136	0	29	295471	994	261821	833	538	1	572	0	5	83467	281	70320	224	20	0	26	0
LAMPASAS	2	31745	106.8	28733	91	57	0	60	0	9	96596	325	85595	272	176	0	187	0	12	194288	654	163686	521	46	0	61	0
LAVACA	7	125704	422.9	113777	362	226	0	238	0	2	21179	71	18767	60	39	0	41	0	0	2343	8	1974	6	1	0	1	0
LEE	1	12379	41.7	11205	36	22	0	23	0	13	136482	459	120939	385	249	0	264	0	1	14982	50	12623	40	4	0	5	0
LEON	7	122663	412.7	111024	353	221	0	233	0	7	69157	233	61281	195	126	0	134	0	0	0	0	0	0	0	0	0	0
LIMESTONE	3	50862	171.1	46036	146	92	0	96	0	5	54694	184	48465	154	100	0	106	0	9	151293	509	127463	406	36	0	47	0
LIVE OAK	10	186022	625.9	168372	536	335	1	353	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLANO	1	10536	35.4	9536	30	19	0	20	0	24	250505	843	221976	706	456	1	485	0	0	0	0	0	0	0	0	0	0
LOVING	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MADISON	1	9848	33.1	8914	28	18	0	19	0	10	102171	344	90535	288	186	0	198	0	0	1030	3	868	3	0	0	0	0
MARTIN	0	0	0.0	0	0	0	0	0	0	0	4639	16	4110	13	8	0	9	0	0	0	0	0	0	0	0	0	0
MASON	0	0	0.0	0	0	0	0	0	0	1	11504	39	10194	32	21	0	22	0	0	0	0	0	0	0	0	0	0
MATAGORDA	4	66293	223.1	60003	191	119	0	126	0	26	268096	902	237564	756	488	1	519	0	5	76595	258	64531	205	18	0	24	0
MAVERICK	13	224837	756.5	203504	648	405	1	426	0	41	420833	1416	372906	1187	767	1	815	1	12	194059	653	163493	520	46	0	60	0
MCCULLOCH	0	7181	24.2	6500	21	13	0	14	0	9	98327	331	87129	277	179	0	190	0	0	0	0	0	0	0	0	0	0
MCLENNAN	71	1264507	4254.6	1144528	3642	2277	4	2397	1	266	2749028	9249	2435955	7751	5009	8	5325	3	99	1647523	5543	1388026	4417	392	1	513	0
MCMULLEN	2	39019	131.3	35317	112	70	0	74	0	1	6494	22	5754	18	12	0	13	0	0	0	0	0	0	0	0	0	0
MEDINA	3	58967	198.4	53372	170	106	0	112	0	20	207980	700	184294	586	379	1	403	0	1	14047	47	11834	38	3	0	4	0
MENARD	0	6063	20.4	5488	17	11	0	11	0	1	12255	41	10859	35	22	0	24	0	0	0	0	0	0	0	0	0	0
MIDLAND	88	1570456	5284.0	1421448	4523	2828	4	2977	2	59	607742	2045	538529	1714	1107	2	1177	1	89	1475546	4965	1243136	3956	351	1	460	0
MILAM	3	48633	163.6	44019	140	88	0	92	0	39	401493	1351	355769	1132	731	1	778	0	10	163494	550	137743	438	39	0	51	0
MILLS	2	29303	98.6	26522	84	53	0	56	0	8	82901	279	73460	234	151	0	161	0	0	0	0	0	0	0	0	0	0
MITCHELL	4	64548	217.2	58424	186	116	0	122	0	0	1577	5	1397	4	3	0	3	0	0	3475	12	2928	9	1	0	1	0
MONTAGUE	1	22501	75.7	20366	65	41	0	43	0	13	130667	440	115786	368	238	0	253	0	10	162490	547	136897	436	39	0	51	0
Montgomery	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOTLEY	0	0	0.0	0	0	0	0	0	0	1	6587	22	5837	19	12	0	13	0	0	0	0	0	0	0	0	0	0
NACOGDOCHES	22	387336	1303.2	350584	1116	697	1	734	0	117	1212500	4080	1074415	3419	2209	3	2348	1	19	314772	1059	265193	844	75	0	98	0
NAVARRO	3	56233	189.2	50897	162	101	0	107	0	30	308983	1040	273794	871	563	1	598	0	18	294959	992	248501	791	70	0	92	0
NOLAN	6	99496	334.8	90056	287	179	0	189	0	17	178115	599	157830	502	325	0	345	0	10	170522	574	143663	457	41	0	53	0
Nueces	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PALO PINTO	4	76832	258.5	69542	221	138	0	146	0	26	267664	901	237181	755	488	1	518	0	15	240710	810	202796	645	57	0	75	0
Parker	10	170394	573.3	154227	491	307	0	323	0	130	1346966	4532	1193567	3798	2454	4	2609	2	71	1170704	3939	986309	3138	279	0	365	0
PECOS	3	57633	193.9	52165	166	104	0	109	0	6	63842	215	56572	180	116	0	124	0	0	5642	19	4753	15	1	0	2	0
PRESIDIO	3	45915	154.5	41559	132	83	0	87	0	5	49955	168	44266	141	91	0	97	0	0	0	0	0	0	0	0	0	0
RAINS	1	10886	36.6	9853	31	20	0	21	0	8	83394	281	73897	235	152	0	162	0	0	0	0	0	0	0	0	0	0
REAGAN	1	25330	85.2	22927	73	46	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REAL	0	8055	27.1	7291	23	15	0	15	0	1	5937	20	5261	17	11	0	12	0	0	0	0	0	0	0	0	0	0
RED RIVER	2	29224	98.3	26451	84	53	0	55	0	14	141850	477	125695	400	258	0	275	0	0	1120	4	943	3	0	0	0	0
REEVES	5	87301	293.7	79017	251	157	0	165	0	2	19946	67	17675	56	36	0	39	0	0	8149	27	6866	22	2	0	3	0
REFUGIO	1	19462	65.5	17615	56	35	0	37	0	1	7904	27	7004	22	14	0	15	0	0	0	0	0	0	0	0	0	0
ROBERTSON	1	23405	78.7	21184	67	42	0	44	0	3	31888	107	28257	90	58	0	62	0	0	0	0	0	0	0	0	0	0
Rockw all	26	472358	1589.3	427540	1360	851	1	895	1	158	1632628	5493	1446696	4603	2975	5	3162	2	95	1582511	5325	1333253	4242	377	1	493	0
RUNNELS	0	0	0.0	0	0	0	0	0	0	6	62344	210	55244	176	114	0	121	0	1	12743	43	10736	34	3	0	4	0
Rusk	1	10290	34.6	9314	30	19	0	20	0	6	63102	212	55916	178	115	0	122	0	11	177507	597	149548	476	42	0	55	0
San Patricio	13	237634	799.6	215087	684	428	1	450	0	56	583636	1964	517168	1646	1063	2	1130	1	23	378735	1274	319082	1015	90	0	118	0
SAN SABA	4	76288	256.7	69050	220	137	0	145	0	3	27832	94	24662	78	51	0	54	0	1	12061	41	10161	32	3	0	4	0
SCHLEICHER	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCURRY	1	9645	32.5	8730	28	17	0	18	0	0	2598	9	2302	7	5	0	5	0	4	67189	226	56606	180	16	0	21	0
SHACKELFORD	2	32067	107.9	29025	92	58	0	61	0	4	40449	136	35843	114	74	0	78	0	0	0	0	0	0	0	0	0	0
Smith	80	1423915	4790.9	1288811	4101	2564	4	2699	2	113	1174684	3952	1040906	3312	2140	3	2275	1	87	1441125	4849	1214136	3863	343	1	449	0
SOMERVELL	0	4515	15.2	4087	13	8	0	9	0	7	69676	234	61741	196	127	0	135	0	0	2596	9	2187	7	1	0	1	0
STARR	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STEPHENS	0	0	0.0	0	0	0	0	0	0	6	61962	208	54905	175	113	0	120	0	0	0	0	0	0	0	0	0	0
STERLING	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STONEWALL	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUTTON	0	0	0.0	0	0	0	0	0	0	2	17163	58	15208	48	31	0	33	0	0	0	0	0	0	0	0	0	0
Tarrant	737	13173191	44322.9	11923290	37939	23719	37	24972	15	1564	16186680	54462	14343260	45639	29491	45	31352	19	1667	27652878	93042	23297332	74129	6583	10	8617	5
TAYLOR	34	603333	2030.0	546088	1738	1086	2	1144	1	49	509017	1713	451048	1435	927	1	986	1	80	1321963	4448	1113743	3544	315	0	412	0
TERRELL	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THROCKMORTON	1	18237	61.4	16507	53	33	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TITUS	4	77529	260.9	70173	223	140	0	147	0	26	266414	896	236073	751	485	1	516	0	7	112830	380	95058	302	27	0	35	0
TOM GREEN	61	1088975	3664.0	985651	3136	1961	3	2064	1	89	917348	3087	812876	2586	1671	3	1777	1	52	858726	2889	723470	2302	204	0	268	0
Travis	315	5624194	18923.3	5090558	16198	10127	16	10662	7	525	5430906	18273	4812407	15313	9895	15	10519	6	646	10715898	36055	9028059	28726	2551	4	3339	2
UPTON	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UVALDE	14	247696	833.4	224194	713	446	1	470	0	32	336383	1132	298074	948	613	1	652	0	33	548476	1845	462086	1470	131	0	171	0
VAL VERDE	9	157653	530.4	142695	454	284	0	299	0	29	301608	1015	267259	850	550	1	584	0	7	118083	397	99484	317	28	0	37	0
VAN ZANDT	1	25812	86.8	23363	74	46	0	49	0	41	421271	1417	373294	1188	768	1	816	1	0	2498	8	2105	7	1	0	1	0
Victoria	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waller	3	55885	188.0	50582	161	101	0	106	0	12	121569	409	107724	343	221	0	235	0	0	8266	28	6964	22	2	0	3	0
WARD	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WASHINGTON	30	538405	1811.5	487320	1551	969	1	1021	1	36	371846	1251	329498	1048	677	1	720	0	33	552098	1858	465139	1480	131	0	172	0
WEBB	28	496008	1668.9	448946	1428	893	1	940	1	275	2844976	9572	2520976	8021	5183	8	5510	3	53	886532	2983	746896	2377	211	0	276	0
WHARTON	9	163879	551.4	148330	472	295	0	311	0	16	164564	554	145822	464	300	0	319	0	30	490695	1651	413407	1315	117	0	153	0
WICHITA	59	1055744	3552.2	955573	3041	1901	3	2001	1	50	518780	1746	459699	1463	945	1	1005	1	51	838701	2822	706599	2248	200	0	261	0
WILBARGER	3	54900	184.7	49691	158	99	0	104	0	7	71157	239	63054	201	130	0	138	0	9	143084	481	120547	384	34	0	45	0
WILLACY	2	33642	113.2	30450	97	61	0	64	0	42	434189	1461	384742	1224	791	1	841	1	27	440514	1482	371130	1181	105	0	137	0
Williamson	116	2080761	7001.0	1883333	5993	3747	6	3944	2	399	4130519	13898	3660115	11646	7525	12	8000	5	305	5062247	17033	4264903	13570	1205	2	1577	1
Wilson	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WINKLER	1	15603	52.5	14123	45	28	0	30	0	0	2350	8	2083	7	4	0	5	0	0	0	0	0	0	0	0	0	0
WISE	18	326272	1097.8	295315	940	587	1	619	0	73	751659	2529	666056	2119	1369	2	1456	1	1	16045	54	13518	43	4	0	5	0
YOUNG	10	176112	592.6	159403	507	317	0	334	0	21	214119	720	189734	604	390	1	415	0	23	374023	1258	315112	1003	89	0	117	0
ZAPATA	2	39514	133.0	35765	114	71	0	75	0	40	417287	1404	369764	1177	760	1	808	0	1	13038	44	10985	35	3	0	4	0
ZAVALA	0	2206	7.4	1997	6	4	0	4	0	5	47261	159	41879	133	86	0	92	0	0	0	0	0	0	0	0	0	0
Total	5290	94536282	318080	85566471	272263	170217	262	179209	111	13900	143890166	484137	127503235	405701	262156	404	278697	172	9756	161871126	544637	136375149	433930	38537	59	50439	31

Table 32: Calculated ASHRAE Standard 90.1-1989 and 1999 Energy Use for Food and Lodging Building Types (USDOE 2004) (Part 1)

Non-attainment Counties	Food									Lodging								
	In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL				In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
Brazoria	63	1867347	6283	1889034	6011	2248	3	2210	1	57	712562	2398	683260	2174	1010	2	914	1
Chambers	1	40772	137	41246	131	49	0	48	0	0	0	0	0	0	0	0	0	0
Collin	302	8901199	29949	9004579	28652	10717	17	10533	7	487	6048611	20351	5799883	18455	8571	13	7758	5
Dallas	342	10097781	33975	10215059	32503	12158	19	11949	7	865	10748030	36163	10306055	32793	15230	23	13785	9
Denton	166	4888349	16447	4945123	15735	5886	9	5784	4	383	4755051	15999	4559516	14508	6738	10	6099	4
El Paso	92	2700589	9086	2731954	8693	3252	5	3196	2	300	3725876	12536	3572662	11368	5279	8	4779	3
Fort Bend	121	3576460	12033	3617997	11512	4306	7	4232	3	182	2265983	7624	2172803	6914	3211	5	2906	2
Galveston	46	1360775	4579	1376579	4380	1638	3	1610	1	106	1320945	4444	1266626	4030	1872	3	1694	1
Hardin	3	103225	347	104424	332	124	0	122	0	0	0	0	0	0	0	0	0	0
Harris	630	18575512	62500	18791251	59792	22365	34	21981	14	1642	20405764	68658	19566648	62259	28914	45	26172	16
Jefferson	44	1299518	4372	1314611	4183	1565	2	1538	1	245	3047832	10255	2922501	9299	4319	7	3909	2
Liberty	3	102494	345	103684	330	123	0	121	0	6	69309	233	66459	211	98	0	89	0
Montgomery	109	3211241	10805	3248537	10336	3866	6	3800	2	195	2428968	8173	2329085	7411	3442	5	3115	2
Orange	5	137617	463	139215	443	166	0	163	0	19	238514	803	228706	728	338	1	306	0
Tarrant	445	13117620	44136	13269970	42224	15794	24	15522	10	1003	12461094	41927	11948675	38019	17657	27	15983	10
Waller	0	3921	13	3967	13	5	0	5	0	0	0	0	0	0	0	0	0	0
Total (Non-attainment)	2372	69984419	235472	70797230	225269	84261	130	82814	51	5490	68228538	229564	65422879	208168	96678	149	87510	54

Affected Counties	Food									Lodging								
	In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL				In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
Bastrop	4	127339	428	128817	410	153	0	151	0	45	559083	1881	536093	1706	792	1	717	0
Bexar	305	8983345	30226	9087679	28916	10816	17	10630	7	1202	14935661	50253	14321484	45569	21163	33	19156	12
Caldwell	3	95275	321	96382	307	115	0	113	0	6	69142	233	66299	211	98	0	89	0
Comal	19	559316	1882	565812	1800	673	1	662	0	47	581977	1958	558045	1776	825	1	746	0
Ellis	17	493987	1662	499724	1590	595	1	585	0	21	266351	896	255398	813	377	1	342	0
Gregg	12	352669	1187	356765	1135	425	1	417	0	80	998050	3358	957008	3045	1414	2	1280	1
Guadalupe	18	544301	1831	550622	1752	655	1	644	0	38	468384	1576	449123	1429	664	1	601	0
Harrison	9	252637	850	255571	813	304	0	299	0	33	409496	1378	392657	1249	580	1	525	0
Hays	32	950392	3198	961430	3059	1144	2	1125	1	59	733196	2467	703046	2237	1039	2	940	1
Henderson	2	70072	236	70885	226	84	0	83	0	2	27774	93	26632	85	39	0	36	0
Hood	3	97853	329	98990	315	118	0	116	0	6	77791	262	74592	237	110	0	100	0
Hunt	4	109897	370	111174	354	132	0	130	0	13	161474	543	154834	493	229	0	207	0
Johnson	14	402313	1354	406985	1295	484	1	476	0	4	53496	180	51296	163	76	0	69	0
Kaufman	8	224310	755	226916	722	270	0	265	0	5	66900	225	64149	204	95	0	86	0
Nueces	19	550791	1853	557188	1773	663	1	652	0	162	2010800	6766	1928113	6135	2849	4	2579	2
Parker	19	555344	1869	561794	1788	669	1	657	0	37	462291	1555	443281	1410	655	1	593	0
Rockwall	25	750692	2526	759410	2416	904	1	888	1	15	190484	641	182651	581	270	0	244	0
Rusk	3	84203	283	85181	271	101	0	100	0	1	11089	37	10633	34	16	0	14	0
San Patricio	6	179660	604	181746	578	216	0	213	0	19	239932	807	230066	732	340	1	308	0
Smith	23	683622	2300	691562	2200	823	1	809	0	120	1495844	5033	1434333	4564	2120	3	1919	1
Travis	172	5083271	17103	5142309	16362	6120	9	6015	4	652	8107053	27277	7773679	24735	11487	18	10398	6
Upshur	1	29601	100	29945	95	36	0	35	0	2	25338	85	24296	77	36	0	32	0
Victoria	8	230383	775	233059	742	277	0	273	0	20	245665	827	235562	750	348	1	315	0
Williamson	81	2401364	8080	2429254	7730	2891	4	2842	2	123	1525664	5133	1462927	4655	2162	3	1957	1
Wilson	1	36663	123	37089	118	44	0	43	0	10	118930	400	114040	363	169	0	153	0
Total (Affected)	808	23849300	80244	24126290	76767	28715	44	28221	17	2723	33841865	113865	32450237	103253	47953	74	43406	27

Table 33: Calculated ASHRAE Standard 90.1-1989 and 1999 Energy Use for Food and Lodging Building Types (USDOE 2004) (Part 2)

ERCOT Counties	Food									Lodging								
	In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL				In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
ANDERSON	1	16119	54	16306	52	19	0	19	0	2	19734	66	18922	60	28	0	25	0
ANDREWS	0	0	0	0	0	0	0	0	0	3	37237	125	35705	114	53	0	48	0
ANGELINA	12	357245	1202	361394	1150	430	1	423	0	29	360732	1214	345898	1101	511	1	463	0
ARANSAS	7	207800	699	210214	669	250	0	246	0	7	82169	276	78791	251	116	0	105	0
ARCHER	0	0	0	0	0	0	0	0	0	4	50754	171	48667	155	72	0	65	0
ATASCOSA	3	88846	299	89877	286	107	0	105	0	9	109701	369	105190	335	155	0	141	0
AUSTIN	0	6142	21	6214	20	7	0	7	0	5	56664	191	54334	173	80	0	73	0
BANDERA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bastrop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAYLOR	0	0	0	0	0	0	0	0	0	2	27034	91	25923	82	38	0	35	0
BEE	1	43192	145	43694	139	52	0	51	0	21	264203	889	253339	806	374	1	339	0
BELL	23	691912	2328	699948	2227	833	1	819	1	326	4048580	13622	3882097	12352	5737	9	5193	3
Bexar	305	8983345	30226	9087679	28916	10816	17	10630	7	1202	14935661	50253	14321484	45569	21163	33	19156	12
BLANCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brazoria	63	1867347	6283	1889034	6011	2248	3	2210	1	57	712562	2398	683260	2174	1010	2	914	1
BRAZOS	28	831891	2799	841552	2678	1002	2	984	1	209	2595034	8731	2488322	7918	3677	6	3328	2
BREWSTER	0	0	0	0	0	0	0	0	0	6	70947	239	68029	216	101	0	91	0
BRISCOE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BROOKS	0	3737	13	3780	12	4	0	4	0	0	2026	7	1943	6	3	0	3	0
BROWN	2	60807	205	61513	196	73	0	72	0	12	153260	516	146957	468	217	0	197	0
BURLESON	0	4030	14	4077	13	5	0	5	0	2	30507	103	29252	93	43	0	39	0
BURNET	3	79763	268	80689	257	96	0	94	0	9	113521	382	108853	346	161	0	146	0
Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CALHOUN	5	143473	483	145139	462	173	0	170	0	1	13003	44	12469	40	18	0	17	0
CALLAHAN	0	1905	6	1927	6	2	0	2	0	0	0	0	0	0	0	0	0	0
CAMERON	45	1327239	4466	1342654	4272	1598	2	1571	1	215	2670151	8984	2560350	8147	3784	6	3425	2
Chambers	1	40772	137	41246	131	49	0	48	0	0	0	0	0	0	0	0	0	0
CHEROKEE	3	75998	256	76880	245	92	0	90	0	26	327581	1102	314110	999	464	1	420	0
CHILDRESS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLAY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COLEMAN	0	1154	4	1167	4	1	0	1	0	1	8690	29	8333	27	12	0	11	0
Collin	302	8901199	29949	9004579	28652	10717	17	10533	7	487	6048611	20351	5799883	18455	8571	13	7758	5
COLORADO	0	1772	6	1793	6	2	0	2	0	4	46663	157	44744	142	66	0	60	0
Comal	19	559316	1882	565812	1800	673	1	662	0	47	581977	1958	558045	1776	825	1	746	0
COMANCHE	0	8353	28	8450	27	10	0	10	0	72	892150	3002	855463	2722	1264	2	1144	1
CONCHO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COOKE	13	394518	1327	399100	1270	475	1	467	0	66	822420	2767	788601	2509	1165	2	1055	1
CORYELL	5	150352	506	152099	484	181	0	178	0	16	204096	687	195704	623	289	0	262	0
COTTLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CROCKETT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CROSBY	0	0	0	0	0	0	0	0	0	1	8518	29	8168	26	12	0	11	0
CULBERSON	0	2931	10	2965	9	4	0	3	0	0	0	0	0	0	0	0	0	0
Dallas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE WITT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DELTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Denton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DIMMIT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DUVAL	0	6185	21	6257	20	7	0	7	0	0	1173	4	1125	4	2	0	2	0
EASTLAND	5	156016	525	157828	502	188	0	185	0	1	7677	26	7362	23	11	0	10	0
ECTOR	10	300004	1009	303488	966	361	1	355	0	125	1557904	5242	1493840	4753	2208	3	1998	1
EDWARDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ellis	17	493987	1662	499724	1590	595	1	585	0	21	266351	896	255398	813	377	1	342	0
ERATH	1	18974	64	19194	61	23	0	22	0	8	96184	324	92229	293	136	0	123	0
FALLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FANNIN	1	24235	82	24517	78	29	0	29	0	4	48807	164	46800	149	69	0	63	0
FAYETTE	1	22474	76	22735	72	27	0	27	0	15	187133	630	179438	571	265	0	240	0
FISHER	0	0	0	0	0	0	0	0	0	2	24882	84	23859	76	35	0	32	0
FOARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fort Bend	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0	0	0	1958	7	1877	6	3	0	3	0
FREESTONE	0	0	0	0	0	0	0	0	0	1	6291	21	6032	19	9	0	8	0
FRIO	1	29774	100	30120	96	36	0	35	0	2	28674	96	27495	87	41	0	37	0
Galveston	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GILLESPIE	3	99134	334	100286	319	119	0	117	0	7	85532	288	82015	261	121	0	110	0
GLASSCOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GONZALES	0	6963	23	7044	22	8	0	8	0	2	19727	66	18915	60	28	0	25	0
GRAYSON	12	341675	1150	345643	1100	411	1	404	0	35	430137	1447	412449	1312	609	1	552	0
GRIMES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guadalupe	18	544301	1831	550622	1752	655	1	644	0	38	468384	1576	449123	1429	664	1	601	0
HALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0	0	4	44384	149	42559	135	63	0	57	0
HARDEMAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harris	630	18575512	62500	18791251	59792	22365	34	21981	14	1642	20405764	68658	19566648	62259	28914	45	26172	16
HASKELL	2	67770	228	68557	218	82	0	80	0	0	0	0	0	0	0	0	0	0
Hays	32	950392	3198	961430	3059	1144	2	1125	1	59	733196	2467	703046	2237	1039	2	940	1
Henderson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HIDALGO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HILL	2	54783	184	55419	176	66	0	65	0	3	36489	123	34989	111	52	0	47	0
Hood	3	97853	329	98990	315	118	0	116	0	6	77791	262	74592	237	110	0	100	0
HOPKINS	3	80285	270	81217	258	97	0	95	0	5	67957	229	65162	207	96	0	87	0
HOUSTON	5	136354	459	137938	439	164	0	161	0	7	86474	291	82918	264	123	0	111	0
HOWARD	0	8633	29	8734	28	10	0	10	0	5	65986	222	63273	201	94	0	85	0
HUDSPETH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hunt	4	109897	370	111174	354	132	0	130	0	13	161474	543	154834	493	229	0	207	0
IRION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JACKSON	0	4540	15	4593	15	5	0	5	0	0	0	0	0	0	0	0	0	0
JEFF DAVIS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JIM HOGG	0	0	0	0	0	0	0	0	0	1	11310	38	10845	35	16	0	15	0

Table 34: Calculated ASHRAE Standard 90.1-1989 and 1999 Energy Use for Food and Lodging Building Types (USDOE 2004) (Part 3)

ERCOT Counties	Food									Lodging								
	In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL				In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
JIM WELLS	6	169675	571	171645	546	204	0	201	0	23	281727	948	270142	860	399	1	361	0
Johnson	14	402313	1354	406985	1295	484	1	476	0	4	53496	180	51296	163	76	0	69	0
JONES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KARNES	0	874	3	884	3	1	0	1	0	1	17449	59	16731	53	25	0	22	0
Kaufman	8	224310	755	226916	722	270	0	265	0	5	66900	225	64149	204	95	0	86	0
KENDALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENEDY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0	0	2	29856	100	28629	91	42	0	38	0
KERR	6	177723	598	179787	572	214	0	210	0	53	660434	2222	633276	2015	936	1	847	1
KIMBLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KINNEY	0	3479	12	3519	11	4	0	4	0	0	0	0	0	0	0	0	0	0
KLEBERG	9	256467	863	259446	826	309	0	303	0	8	101491	341	97318	310	144	0	130	0
KNOX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA SALLE	0	3151	11	3187	10	4	0	4	0	2	18700	63	17931	57	26	0	24	0
LAMAR	1	39594	133	40054	127	48	0	47	0	2	25902	87	24837	79	37	0	33	0
LAMPASAS	3	92164	310	93234	297	111	0	109	0	7	82702	278	79301	252	117	0	106	0
LAVACA	0	1111	4	1124	4	1	0	1	0	1	9654	32	9257	29	14	0	12	0
LEE	0	7107	24	7190	23	9	0	8	0	0	0	0	0	0	0	0	0	0
LEON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIMESTONE	2	71769	241	72602	231	86	0	85	0	4	43522	146	41732	133	62	0	56	0
LIVE OAK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLANO	0	0	0	0	0	0	0	0	0	56	698508	2350	669785	2131	990	2	896	1
LOVING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MADISON	0	488	2	494	2	1	0	1	0	0	0	0	0	0	0	0	0	0
MARTIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MASON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MATAGORDA	1	36334	122	36756	117	44	0	43	0	9	105652	355	101307	322	150	0	136	0
MAVERICK	3	92055	310	93124	296	111	0	109	0	28	350147	1178	335748	1068	496	1	449	0
MCCULLOCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCLENNAN	26	781531	2630	790608	2516	941	1	925	1	122	1512941	5090	1450727	4616	2144	3	1940	1
MCMULLEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDINA	0	6663	22	6741	21	8	0	8	0	0	865	3	829	3	1	0	1	0
MENARD	0	0	0	0	0	0	0	0	0	0	2879	10	2761	9	4	0	4	0
MIDLAND	24	699951	2355	708080	2253	843	1	828	1	51	629814	2119	603915	1922	892	1	808	0
MILAM	3	77556	261	78457	250	93	0	92	0	0	0	0	0	0	0	0	0	0
MILLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MITCHELL	0	1649	6	1668	5	2	0	2	0	5	63978	215	61347	195	91	0	82	0
MONTAGUE	3	77080	259	77975	248	93	0	91	0	6	75501	254	72397	230	107	0	97	0
Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOTLEY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NACOGDOCHES	5	149317	502	151052	481	180	0	177	0	27	334937	1127	321163	1022	475	1	430	0
NAVARRO	5	139919	471	141544	450	168	0	166	0	14	170536	574	163523	520	242	0	219	0
NOLAN	3	80890	272	81829	260	97	0	96	0	8	98350	331	94306	300	139	0	126	0
Nueces	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PALO PINTO	4	114185	384	115511	368	137	0	135	0	3	32481	109	31145	99	46	0	42	0
Parker	19	555344	1869	561794	1788	669	1	657	0	37	462291	1555	443281	1410	655	1	593	0
PECOS	0	2676	9	2707	9	3	0	3	0	9	117532	395	112699	359	167	0	151	0
PRESIDIO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RAINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REAGAN	0	0	0	0	0	0	0	0	0	0	4443	15	4260	14	6	0	6	0
REAL	0	0	0	0	0	0	0	0	0	4	45267	152	43406	138	64	0	58	0
RED RIVER	0	531	2	537	2	1	0	1	0	0	0	0	0	0	0	0	0	0
REEVES	0	3866	13	3911	12	5	0	5	0	4	50132	169	48071	153	71	0	64	0
REFUGIO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROBERTSON	0	0	0	0	0	0	0	0	0	1	17112	58	16408	52	24	0	22	0
Rockwall	25	750692	2526	759410	2416	904	1	888	1	15	190484	641	182651	581	270	0	244	0
RUNNELS	0	6045	20	6115	19	7	0	7	0	0	0	0	0	0	0	0	0	0
Rusk	3	84203	283	85181	271	101	0	100	0	1	11089	37	10633	34	16	0	14	0
San Patricio	6	179660	604	181746	578	216	0	213	0	19	239932	807	230066	732	340	1	308	0
SAN SABA	0	5721	19	5788	18	7	0	7	0	0	0	0	0	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCURRY	1	31872	107	32242	103	38	0	38	0	2	28790	97	27606	88	41	0	37	0
SHACKELFORD	0	0	0	0	0	0	0	0	0	2	27679	93	26541	84	39	0	36	0
Smith	23	683622	2300	691562	2200	823	1	809	0	120	1495844	5033	1434333	4564	2120	3	1919	1
SOMERVELL	0	1232	4	1246	4	1	0	1	0	1	7419	25	7114	23	11	0	10	0
STARR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STEPHENS	0	0	0	0	0	0	0	0	0	1	14250	48	13664	43	20	0	18	0
STERLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUTTON	0	0	0	0	0	0	0	0	0	1	14097	47	13517	43	20	0	18	0
Tarrant	445	13117620	44136	13269970	42224	15794	24	15522	10	1003	12461094	41927	11948675	38019	17657	27	15983	10
TAYLOR	21	627096	2110	634379	2019	755	1	742	0	60	739461	2488	709053	2256	1048	2	948	1
TERRELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THROCKMORTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TITUS	2	53523	180	54144	172	64	0	63	0	0	1298	4	1245	4	2	0	2	0
TOM GREEN	14	407352	1371	412083	1311	490	1	482	0	112	1394077	4691	1336751	4253	1975	3	1788	1
Travis	172	5083271	17103	5142309	16362	6120	9	6015	4	652	8107053	27277	7773679	24735	11487	18	10398	6
UPTON	0	0	0	0	0	0	0	0	0	0	1697	6	1627	5	2	0	2	0
UVALDE	9	260179	875	263201	837	313	0	308	0	5	60581	204	58090	185	86	0	78	0
VAL VERDE	2	56015	188	56665	180	67	0	66	0	9	106443	358	102066	325	151	0	137	0
VAN ZANDT	0	1185	4	1199	4	1	0	1	0	0	2574	9	2468	8	4	0	3	0
Victoria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waller	0	3921	13	3967	13	5	0	5	0	0	0	0	0	0	0	0	0	0
WARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WASHINGTON	9	261897	881	264939	843	315	0	310	0	12	143166	482	137278	437	203	0	184	0
WEBB	14	420542	1415	425426	1354	506	1	498	0	95	1183021	3980	1134374	3609	1676	3	1517	1
WHARTON	8	232770	783	235473	749	280	0	275	0	6	79399	267	76134	242	113	0	102	0
WICHITA	13	397852	1339	402473	1281	479	1	471	0	165	2054694	6913	1970202	6269	2911	4	2635	2
WILBARGER	2	67874	228	68663	218	82	0	80	0	11	137552	463	131896	420	195	0	176	0
WILLACY	7	208966	703	211392	673	252	0	247	0	1	15831	53	15180	48	22	0	20	0
Williamson	81	2401364	8080	2429254	7730	2891	4	2842	2	123	1525664	5133	1462927	4655	2162	3	1957	1
Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WINKLER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WISE	0	7611	26	7700	24	9	0	9	0	47	586882	1975	562748	1791	832	1	753	0
YOUNG	6	177424	597	179485	571	214	0	210	0	6	77078	259	73908	235	109	0	99	0
ZAPATA	0	6185	21	6257	20	7	0	7	0	1	17192	58	16485	52	24	0	22	0
ZAVALA	0	0	0	0	0	0	0	0	0	1	14859	50	14248	45	21	0	19	0
Total	2603	76786364	258358	77678174	247163	92451	142	90863	56	7815	97120225	326774	93126496	296318	137617	212	124566	77

Table 35: Calculated ASHRAE Standard 90.1-1989 and 1999 Energy Use for Office and Warehouse Building Types (USDOE 2004) (Part 1)

Non-attainment Counties	Office									Warehouse								
	In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL				In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
Brazoria	70	1006377	3386	899582	2862	390	1	439	0	115	349290	1175	599788	1908	945	1	1051	1
Chambers	13	187704	632	167785	534	73	0	82	0	0	0	0	0	0	0	0	0	0
Collin	683	9882059	33249	8833392	28107	3830	6	4315	3	490	1482606	4988	2545874	8101	4009	6	4460	3
Dallas	2020	29244380	98397	26141015	83178	11334	17	12769	8	2910	8813374	29654	15133992	48155	23834	37	26511	16
Denton	315	4553131	15320	4069960	12950	1765	3	1988	1	758	2294228	7719	3939561	12535	6204	10	6901	4
El Paso	461	6675507	22461	5967113	18987	2587	4	2915	2	1116	3378773	11368	5801901	18461	9137	14	10163	6
Fort Bend	347	5018629	16886	4486060	14274	1945	3	2191	1	484	1464384	4927	2514585	8001	3960	6	4405	3
Galveston	174	2512353	8453	2245746	7146	974	1	1097	1	62	187161	630	321387	1023	506	1	563	0
Hardin	1	19015	64	16997	54	7	0	8	0	0	0	0	0	0	0	0	0	0
Harris	2392	34622642	116492	30948544	98475	13419	21	15117	9	4792	14512762	48830	24920764	79295	39246	60	43655	27
Jefferson	102	1482297	4987	1324998	4216	574	1	647	0	48	144376	486	247917	789	390	1	434	0
Liberty	15	223620	752	199890	636	87	0	98	0	2	7119	24	12224	39	19	0	21	0
Montgomery	321	4641833	15618	4149249	13202	1799	3	2027	1	204	619201	2083	1063268	3383	1674	3	1863	1
Orange	18	258081	868	230694	734	100	0	113	0	15	44942	151	77172	246	122	0	135	0
Tarrant	902	13052258	43916	11667174	37124	5059	8	5699	4	1875	5679685	19110	9752939	31033	15359	24	17085	11
Waller	0	5860	20	5238	17	2	0	3	0	14	41200	139	70747	225	111	0	124	0
Total (Non-attainment)	7833	113385746	381501	101353437	322495	43944	68	49506	31	12884	39019101	131285	67002119	213193	105517	162	117370	72

Affected Counties	Office									Warehouse								
	In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL				In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
Bastrop	6	86529	291	77347	246	34	0	38	0	6	18800	63	32283	103	51	0	57	0
Bexar	886	12820683	43137	11460173	36465	4969	8	5598	3	904	2737440	9210	4700628	14957	7403	11	8234	5
Caldwell	2	22441	76	20059	64	9	0	10	0	11	33795	114	58032	185	91	0	102	0
Comal	52	746267	2511	667074	2123	289	0	326	0	28	83568	281	143500	457	226	0	251	0
Ellis	26	369490	1243	330281	1051	143	0	161	0	300	907390	3053	1558136	4958	2454	4	2729	2
Gregg	25	367624	1237	328613	1046	142	0	161	0	42	128635	433	220886	703	348	1	387	0
Guadalupe	66	949774	3196	848985	2701	368	1	415	0	142	430184	1447	738696	2350	1163	2	1294	1
Harrison	13	183113	616	163682	521	71	0	80	0	10	30150	101	51773	165	82	0	91	0
Hays	137	1978598	6657	1768632	5628	767	1	864	1	65	195820	659	336254	1070	530	1	589	0
Henderson	3	39054	131	34910	111	15	0	17	0	17	52343	176	89881	286	142	0	157	0
Hood	10	151613	510	135524	431	59	0	66	0	0	0	0	0	0	0	0	0	0
Hunt	18	253675	854	226756	722	98	0	111	0	11	31929	107	54827	174	86	0	96	0
Johnson	8	116939	393	104529	333	45	0	51	0	64	193180	650	331721	1055	522	1	581	0
Kaufman	15	211365	711	188936	601	82	0	92	0	79	238489	802	409524	1303	645	1	717	0
Nueces	121	1758539	5917	1571925	5002	682	1	768	0	124	374541	1260	643147	2046	1013	2	1127	1
Parker	8	119804	403	107091	341	46	0	52	0	6	19203	65	32975	105	52	0	58	0
Rockwall	26	376948	1268	336947	1072	146	0	165	0	36	110448	372	189658	603	299	0	332	0
Rusk	2	34329	116	30686	98	13	0	15	0	2	7269	24	12482	40	20	0	22	0
San Patricio	75	1086356	3655	971074	3090	421	1	474	0	241	729781	2455	1253152	3987	1974	3	2195	1
Smith	121	1755115	5905	1568865	4992	680	1	766	0	147	444233	1495	762820	2427	1201	2	1336	1
Travis	527	7627861	25665	6818405	21695	2956	5	3330	2	398	1205668	4057	2070327	6588	3260	5	3627	2
Upshur	5	72923	245	65184	207	28	0	32	0	2	5713	19	9809	31	15	0	17	0
Victoria	17	248022	835	221702	705	96	0	108	0	10	29570	99	50777	162	80	0	89	0
Williamson	134	1944494	6543	1738147	5531	754	1	849	1	119	359954	1211	618099	1967	973	1	1083	1
Wilson	0	4033	14	3605	11	2	0	2	0	0	0	0	0	0	0	0	0	0
Total (Affected)	2302	33325590	112128	29789133	94786	12916	20	14550	9	2763	8368102	28156	14369388	45722	22629	35	25171	16

Table 36: Calculated ASHRAE Standard 90.1-1989 and 1999 Energy Use for Office and Warehouse Building Types (USDOE 2004) (Part 2)

ERCOT Counties	Office									Warehouse								
	In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL				In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
ANDERSON	2	22984	77	20545	65	9	0	10	0	1	3419	12	5871	19	9	0	10	0
ANDREWS	3	43370	146	38768	123	17	0	19	0	0	0	0	0	0	0	0	0	0
ANGELINA	29	420152	1414	375566	1195	163	0	183	0	7	20386	69	35007	111	55	0	61	0
ARANSAS	7	95704	322	85548	272	37	0	42	0	0	589	2	1012	3	2	0	2	0
ARCHER	4	59114	199	52841	168	23	0	26	0	2	6304	21	10826	34	17	0	19	0
ATASCOSA	9	127771	430	114212	363	50	0	56	0	2	6317	21	10847	35	17	0	19	0
AUSTIN	5	65998	222	58995	188	26	0	29	0	194	588084	1979	1009835	3213	1590	2	1769	1
BANDERA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bastrop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAYLOR	2	31487	106	28146	90	12	0	14	0	0	0	0	0	0	0	0	0	0
BEE	21	307723	1035	275068	875	119	0	134	0	0	664	2	1140	4	2	0	2	0
BELL	326	4715461	15866	4215064	13412	1828	3	2059	1	118	356792	1200	612669	1949	965	1	1073	1
Bexar	1202	17395858	58531	15549838	49478	6742	10	7595	5	904	2737440	9210	4700628	14957	7403	11	8234	5
BLANCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brazoria	57	829935	2792	741863	2361	322	0	362	0	115	349290	1175	599788	1908	945	1	1051	1
BRAZOS	209	3022487	10170	2701746	8597	1171	2	1320	1	54	164393	553	282289	898	445	1	494	0
BREWSTER	6	82633	278	73864	235	32	0	36	0	6	16803	57	28854	92	45	0	51	0
BRISCOE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BROOKS	0	2360	8	2109	7	1	0	1	0	0	0	0	0	0	0	0	0	0
BROWN	12	178504	601	159562	508	69	0	78	0	6	18864	63	32392	103	51	0	57	0
BURLESON	2	35532	120	31761	101	14	0	16	0	0	0	0	0	0	0	0	0	0
BURNET	9	132220	445	118189	376	51	0	58	0	2	7333	25	12592	40	20	0	22	0
Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CALHOUN	1	15145	51	13538	43	6	0	7	0	0	574	2	985	3	2	0	2	0
CALLAHAN	0	0	0	0	0	0	0	0	0	1	3790	13	6508	21	10	0	11	0
CAMERON	215	3109977	10464	2779951	8845	1205	2	1358	1	298	903667	3041	1551743	4937	2444	4	2718	2
Chambers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHEROKEE	26	381540	1284	341052	1085	148	0	167	0	34	101948	343	175061	557	276	0	307	0
CHILDRESS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLAY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COLEMAN	1	10122	34	9048	29	4	0	4	0	0	0	0	0	0	0	0	0	0
Collin	487	7044936	23704	6297339	20037	2730	4	3076	2	490	1482606	4988	2545874	8101	4009	6	4460	3
COLORADO	4	54350	183	48582	155	21	0	24	0	0	358	1	615	2	1	0	1	0
Comal	47	677840	2281	605908	1928	263	0	296	0	28	83568	281	143500	457	226	0	251	0
COMANCHE	72	1039104	3496	928836	2955	403	1	454	0	2	4758	16	8171	26	13	0	14	0
CONCHO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COOKE	66	957889	3223	856239	2724	371	1	418	0	19	58911	198	101160	322	159	0	177	0
CORYELL	16	237715	800	212489	676	92	0	104	0	7	21164	71	36343	116	57	0	64	0
COTTLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CROCKETT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CROSBY	1	9921	33	8869	28	4	0	4	0	0	0	0	0	0	0	0	0	0
CULBERSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE WITT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DELTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Denton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DIMMIT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DUVAL	0	1366	5	1221	4	1	0	1	0	0	0	0	0	0	0	0	0	0
EASTLAND	1	8942	30	7993	25	3	0	4	0	0	0	0	0	0	0	0	0	0
ECTOR	125	1814521	6105	1621967	5161	703	1	792	0	219	661970	2227	1136710	3617	1790	3	1991	1
EDWARDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ellis	21	310224	1044	277304	882	120	0	135	0	300	907390	3053	1558136	4958	2454	4	2729	2
ERATH	8	112028	377	100140	319	43	0	49	0	2	4921	17	8450	27	13	0	15	0
FALLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FANNIN	4	56847	191	50814	162	22	0	25	0	5	13683	46	23495	75	37	0	41	0
FAYETTE	15	217958	733	194828	620	84	0	95	0	1	1866	6	3204	10	5	0	6	0
FISHER	2	28981	98	25906	82	11	0	13	0	0	0	0	0	0	0	0	0	0
FOARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fort Bend	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FRANKLIN	0	2280	8	2038	6	1	0	1	0	26	80036	269	137434	437	216	0	241	0
FREESTONE	1	7327	25	6550	21	3	0	3	0	0	53	0	91	0	0	0	0	0
FRIO	2	33397	112	29853	95	13	0	15	0	0	0	0	0	0	0	0	0	0
Galveston	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GILLESPIE	7	99621	335	89049	283	39	0	43	0	5	15750	53	27046	86	43	0	47	0
GLASSCOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GONZALES	2	22976	77	20538	65	9	0	10	0	0	0	0	0	0	0	0	0	0
GRAYSON	35	500989	1686	447825	1425	194	0	219	0	90	273066	919	468898	1492	738	1	821	1
GRIMES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guadalupe	38	545536	1836	487644	1552	211	0	238	0	142	430184	1447	738696	2350	1163	2	1294	1
HALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HAMILTON	4	51695	174	46209	147	20	0	23	0	0	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harris	1642	23766993	79967	21244879	67599	9211	14	10377	6	4792	14512762	48830	24920764	79295	39246	60	43655	27
HASKELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hays	59	853968	2873	763347	2429	331	1	373	0	65	195820	659	336254	1070	530	1	589	0
Henderson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HIDALGO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HILL	3	42500	143	37990	121	16	0	19	0	0	0	0	0	0	0	0	0	0
Hood	6	90605	305	80990	258	35	0	40	0	0	0	0	0	0	0	0	0	0
HOPKINS	5	79150	266	70751	225	31	0	35	0	12	36340	122	62402	199	98	0	109	0
HOUSTON	7	100718	339	90030	286	39	0	44	0	0	608	2	1044	3	2	0	2	0
HOWARD	5	76855	259	68700	219	30	0	34	0	0	0	0	0	0	0	0	0	0
HUDSPETH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hunt	13	188072	633	168114	535	73	0	82	0	11	31929	107	54827	174	86	0	96	0
IRION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JACKSON	0	0	0	0	0	0	0	0	0	0	913	3	1568	5	2	0	3	0
JEFF DAVIS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JIM HOGG	1	13173	44	11775	37	5	0	6	0	0	0	0	0	0	0	0	0	0

Table 37: Calculated ASHRAE Standard 90.1-1989 and 1999 Energy Use for Office and Warehouse Building Types (USDOE 2004) (Part 3)

ERCOT Counties	Office									Warehouse								
	In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL				In	Electricity (kWh/yr), PNNL				Gas (mBtu/yr), PNNL			
	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	thousand	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)	1989 (Annual)	1989 (OSD)	1999 (Annual)	1999 (OSD)
JIM WELLS	23	328133	1104	293312	933	127	0	143	0	4	11339	38	19470	62	31	0	34	0
Johnson	4	62308	210	55696	177	24	0	27	0	64	193180	650	331721	1055	522	1	581	0
JONES	0	0	0	0	0	0	0	0	0	4	11506	39	19757	63	31	0	35	0
KARNES	1	20323	68	18166	58	8	0	9	0	0	0	0	0	0	0	0	0	0
Kaufman	5	77920	262	69651	222	30	0	34	0	79	238489	802	409524	1303	645	1	717	0
KENDALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENEDY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENT	2	34774	117	31084	99	13	0	15	0	0	0	0	0	0	0	0	0	0
KERR	53	769221	2588	687592	2188	298	0	336	0	0	1162	4	1995	6	3	0	3	0
KIMBLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KINNEY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KLEBERG	8	118209	398	105665	336	46	0	52	0	1	2838	10	4874	16	8	0	9	0
KNOX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA SALLE	2	21780	73	19469	62	8	0	10	0	0	0	0	0	0	0	0	0	0
LAMAR	2	30169	102	26967	86	12	0	13	0	2	4642	16	7971	25	13	0	14	0
LAMPASAS	7	96325	324	86103	274	37	0	42	0	0	0	0	0	0	0	0	0	0
LAVACA	1	11244	38	10051	32	4	0	5	0	0	0	0	0	0	0	0	0	0
LEE	0	0	0	0	0	0	0	0	0	0	1435	5	2463	8	4	0	4	0
LEON	0	0	0	0	0	0	0	0	0	0	166	1	285	1	0	0	0	0
LIMESTONE	4	50691	171	45311	144	20	0	22	0	0	1485	5	2550	8	4	0	4	0
LIVE OAK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLANO	56	813566	2737	727232	2314	315	0	355	0	0	98	0	169	1	0	0	0	0
LOVING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MADISON	0	0	0	0	0	0	0	0	0	0	221	1	380	1	1	0	1	0
MARTIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MASON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MATAGORDA	9	123055	414	109996	350	48	0	54	0	7	20739	70	35612	113	56	0	62	0
MAVERICK	28	407823	1372	364545	1160	158	0	178	0	1	1627	5	2793	9	4	0	5	0
MCCULLOCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCLENNAN	122	1762152	5929	1575155	5012	683	1	769	0	121	366536	1233	629402	2003	991	2	1103	1
MCMULLEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDINA	0	1007	3	900	3	0	0	0	0	1	2069	7	3553	11	6	0	6	0
MENARD	0	3353	11	2997	10	1	0	1	0	0	0	0	0	0	0	0	0	0
MIDLAND	51	733557	2468	655713	2086	284	0	320	0	18	54249	183	93154	296	147	0	163	0
MILAM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MILLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MITCHELL	5	74516	251	66609	212	29	0	33	0	0	0	0	0	0	0	0	0	0
MONTAGUE	6	87938	296	78606	250	34	0	38	0	1	2279	8	3914	12	6	0	7	0
Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOTLEY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NACOGDOCHES	27	390107	1313	348710	1110	151	0	170	0	13	40661	137	69821	222	110	0	122	0
NAVARRO	14	198626	668	177549	565	77	0	87	0	34	102711	346	176372	561	278	0	309	0
NOLAN	8	114550	385	102394	326	44	0	50	0	0	0	0	0	0	0	0	0	0
Nueces	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PALO PINTO	3	37831	127	33817	108	15	0	17	0	2	4579	15	7863	25	12	0	14	0
Parker	37	538439	1812	481301	1531	209	0	235	0	6	19203	65	32975	105	52	0	58	0
PECOS	9	136892	461	122365	389	53	0	60	0	0	0	0	0	0	0	0	0	0
PRESIDIO	0	0	0	0	0	0	0	0	0	0	884	3	1517	5	2	0	3	0
RAINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REAGAN	0	5175	17	4626	15	2	0	2	0	0	0	0	0	0	0	0	0	0
REAL	4	52724	177	47129	150	20	0	23	0	0	1217	4	2090	7	3	0	4	0
RED RIVER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REEVES	4	58390	196	52194	166	23	0	25	0	0	0	0	0	0	0	0	0	0
REFUGIO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROBERTSON	1	19931	67	17816	57	8	0	9	0	1	3671	12	6303	20	10	0	11	0
Rockwall	15	221860	746	198317	631	86	0	97	0	36	110448	372	189658	603	299	0	332	0
RUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rusk	1	12916	43	11545	37	5	0	6	0	2	7269	24	12482	40	20	0	22	0
San Patricio	19	279453	940	249798	795	108	0	122	0	241	729781	2455	1253152	3987	1974	3	2195	1
SAN SABA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCURRY	2	33532	113	29974	95	13	0	15	0	12	35410	119	60805	193	96	0	107	0
SHACKELFORD	2	32238	108	28817	92	12	0	14	0	0	0	0	0	0	0	0	0	0
Smith	120	1742239	5862	1557356	4955	675	1	761	0	147	444233	1495	762820	2427	1201	2	1336	1
SOMERVELL	1	8642	29	7725	25	3	0	4	0	1	2752	9	4725	15	7	0	8	0
STARR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STEPHENS	1	16597	56	14836	47	6	0	7	0	0	0	0	0	0	0	0	0	0
STERLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUTTON	1	16419	55	14676	47	6	0	7	0	0	0	0	0	0	0	0	0	0
Tarrant	1003	14513680	48833	12973512	41280	5625	9	6337	4	1875	5679685	19110	9752939	31033	15359	24	17085	11
TAYLOR	60	861264	2898	769868	2450	334	1	376	0	52	156657	527	269006	856	424	1	471	0
TERRELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THROCKMORTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TITUS	0	1512	5	1352	4	1	0	1	0	0	0	0	0	0	0	0	0	0
TOM GREEN	112	1623709	5463	1451404	4618	629	1	709	0	33	99397	334	170680	543	269	0	299	0
Travis	652	9442444	31770	8440427	26856	3660	6	4123	3	398	1205668	4057	2070327	6588	3260	5	3627	2
UPTON	0	1976	7	1766	6	1	0	1	0	0	0	0	0	0	0	0	0	0
UVALDE	5	70560	237	63073	201	27	0	31	0	8	23882	80	41009	130	65	0	72	0
VAL VERDE	9	123976	417	110820	353	48	0	54	0	3	9904	33	17006	54	27	0	30	0
VAN ZANDT	0	2998	10	2680	9	1	0	1	0	0	863	3	1481	5	2	0	3	0
Victoria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waller	0	0	0	0	0	0	0	0	0	14	41200	139	70747	225	111	0	124	0
WARD	0	0	0	0	0	0	0	0	0	0	207	1	355	1	1	0	1	0
WASHINGTON	12	166748	561	149053	474	65	0	73	0	25	75930	255	130384	415	205	0	228	0
WEBB	95	1377888	4636	1231669	3919	534	1	602	0	118	357701	1204	614231	1954	967	1	1076	1
WHARTON	6	92478	311	82664	263	36	0	40	0	11	34233	115	58784	187	93	0	103	0
WICHITA	165	2393143	8052	2139186	6807	927	1	1045	1	28	84529	284	145150	462	229	0	254	0
WILBARGER	11	160210	539	143209	456	62	0	70	0	1	4339	15	7451	24	12	0	13	0
WILLACY	1	18439	62	16482	52	7	0	8	0	7	21743	73	37337	119	59	0	65	0
Williamson	123	1776971	5979	1588402	5054	689	1	776	0	119	359954	1211	618099	1967	973	1	1083	1
Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WINKLER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WISE	47	683553	2300	611015	1944	265	0	298	0	0	169	1	290	1	0	0	1	0
YOUNG	6	89774	302	80248	255	35	0	39	0	2	4742	16	8144	26	13	0	14	0
ZAPATA	1	20023	67	17899	57	8	0	9	0	0	0	0	0	0	0	0	0	0
ZAVALA	1	17307	58	15470	49	7	0	8	0	0	647	2	1111	4	2	0	2	0
Total	7815	113117832	380600	101113954	321733	43841	67	49389	31	11452	34683641	116698	59557432	189505	93793	144	104329	64

Table 38: Calculated ASHRAE Standard 90.1-1989 and 1999 Annual Electricity and Natural Gas Savings (USDOE 2004). A decrease in energy use is negative (i.e., savings); a positive value represents an energy use increase (+) (Part 1)

Counties	Assembly		Education		Retail		Food		Lodging		Office		Warehouse		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	MWh/yr	Therm/yr
Non-attainment Counties																		
(square feet in thousands)																		
Brazoria	-159072	159	-431167	435	-620030	289	21688	-39	-29302	-96	-106795	49	250498	106	-1074180	905	1149	-9686
Chambers	-11534	12	-39471	40	-13538	6	474	-1	0	0	-19919	9	0	0	-83988	66	90	-707
Collin	-779172	781	-1148359	1159	-2955535	1380	103380	-184	-248728	-813	-1048668	485	1063269	450	-5013813	3258	5365	-34864
Dallas	-1541753	1546	-2084932	2105	-3352845	1565	117277	-209	-441975	-1444	-3103366	1434	6320617	2677	-4086976	7674	4373	-82112
Denton	-554879	556	-1227403	1239	-1623117	758	56774	-101	-195535	-639	-483171	223	1645333	697	-2381997	2733	2549	-29245
El Paso	-499679	501	-879666	888	-896698	419	31365	-56	-153214	-501	-708394	327	2423128	1026	-683157	2605	731	-27871
Fort Bend	-357130	358	-643103	649	-1187520	554	41538	-74	-93181	-304	-532569	246	1050201	445	-1721763	1874	1842	-20053
Galveston	-142367	143	-232164	234	-451829	211	15804	-28	-54319	-178	-266607	123	134225	57	-997257	562	1067	-6018
Hardin	-10566	11	-44969	45	-34275	16	1199	-2	0	0	-2018	1	0	0	-90628	71	97	-757
Harris	-2414134	2420	-3477000	3510	-6167773	2879	215739	-384	-839116	-2742	-3674098	1698	10408002	4409	-5948379	11790	6365	-126152
Jefferson	-149550	150	-138418	140	-431489	201	15093	-27	-125331	-410	-157299	73	103541	44	-883454	171	945	-1832
Liberty	-7960	8	-201024	203	-34032	16	1190	-2	-2850	-9	-23730	11	5105	2	-263301	228	282	-2445
Montgomery	-298164	299	-561836	567	-1066253	498	37296	-66	-99883	-326	-492584	228	444067	188	-2037356	1387	2180	-14839
Orange	-18806	19	-125590	127	-45694	21	1598	-3	-9808	-32	-27387	13	32231	14	-193455	158	207	-1695
Tarrant	-1249901	1253	-1843420	1861	-4355546	2033	152350	-271	-512419	-1674	-1385084	640	4073254	1725	-5120766	5567	5479	-59567
Waller	-5302	5	-13845	14	-1302	1	46	0	0	0	-622	0	29547	13	8522	33	-9	-349
Total (Non-attainment)	-8199970	8220	-13092365	13216	-23237474	10848	812811	-1447	-2805660	-9168	-12032309	5562	27983018	11853	-30571949	39083	32712	-418192
Affected Counties																		
(square feet in thousands)																		
Bastrop	-9255	9	-62341	63	-42281	20	1479	-3	-22990	-75	-9182	4	13483	6	-131088	24	140	-258
Bexar	-902452	905	-2099430	2119	-2982810	1392	104334	-186	-614177	-2007	-1360510	629	1963188	832	-5891857	3684	6304	-39419
Caldwell	-3545	4	-70206	71	-31635	15	1107	-2	-2843	-9	-2381	1	24237	10	-85267	89	91	-955
Comal	-42152	42	-170367	172	-185714	87	6496	-12	-23932	-78	-79193	37	59932	25	-434929	273	465	-2923
Ellis	-77707	78	-137676	139	-164022	77	5737	-10	-10953	-36	-39210	18	650746	276	226915	541	-243	-5791
Gregg	-81509	82	-39467	40	-117099	55	4096	-7	-41041	-134	-39012	18	92252	39	-221781	92	237	-984
Guadalupe	-35372	35	-165551	167	-180728	84	6322	-11	-19261	-63	-100788	47	308512	131	-186868	390	200	-4173
Harrison	-66887	67	-71992	73	-83885	39	2934	-5	-16839	-55	-19432	9	21623	9	-234478	137	251	-1463
Hays	-126555	127	-257771	260	-315566	147	11038	-20	-30150	-99	-209966	97	140435	59	-788535	573	844	-6128
Henderson	-7170	7	-24860	25	-23266	11	814	-1	-1142	-4	-4144	2	37538	16	-22231	56	24	-597
Hood	-57855	58	-72923	74	-32491	15	1136	-2	-3199	-10	-16089	7	0	0	-181420	142	194	-1517
Hunt	-28029	28	-94365	95	-36490	17	1276	-2	-6640	-22	-26920	12	22898	10	-168270	139	180	-1483
Johnson	-15983	16	-157714	159	-133583	62	4673	-8	-2200	-7	-12409	6	138541	59	-178676	286	191	-3065
Kaufman	-33385	33	-139599	141	-74480	35	2605	-5	-2751	-9	-22430	10	171035	72	-99004	278	106	-2978
Nueces	-172121	173	-177329	179	-182884	85	6397	-11	-82687	-270	-186613	86	268606	114	-526631	355	563	-3802
Parker	-16167	16	-153399	155	-184395	86	6450	-11	-19010	-62	-12713	6	13772	6	-365464	195	391	-2089
Rockwall	-44818	45	-185932	188	-249258	116	8719	-16	-7833	-26	-40001	18	79209	34	-439914	360	471	-3851
Rusk	-976	1	-7186	7	-27959	13	978	-2	-456	-1	-3643	2	5213	2	-34030	22	36	-235
San Patricio	-22547	23	-66467	67	-59654	28	2087	-4	-9866	-32	-115282	53	523371	222	251640	357	-269	-3815
Smith	-135104	135	-133779	135	-226989	106	7940	-14	-61511	-201	-186250	86	318587	135	-417106	382	446	-4091
Travis	-533636	535	-618499	624	-1687838	788	59038	-105	-333374	-1089	-809456	374	864659	366	-3059106	1493	3273	-15977
Upshur	-18468	19	-34021	34	-9829	5	344	-1	-1042	-3	-7738	4	4097	2	-66657	59	71	-629
Victoria	-28812	29	-19052	19	-76496	36	2676	-5	-10102	-33	-26320	12	21207	9	-136900	67	146	-719
Williamson	-197427	198	-470404	475	-797344	372	27890	-50	-62738	-205	-206346	95	258145	109	-1448224	995	1550	-10647
Wilson	-3802	4	-28244	29	-12173	6	426	-1	-4891	-16	-428	0	0	0	-49113	21	53	-230
Total (Affected)	-2661737	2668	-5458575	5510	-7918870	3697	276990	-493	-1391628	-4548	-3536457	1635	6001285	2542	-14688991	11011	15717	-117819

Table 39: Calculated ASHRAE Standard 90.1-1989 and 1999 Annual Electricity and Natural Gas Savings (USDOE 2004). A decrease in energy use is negative (i.e., savings); a positive value represents an energy use increase (+) (Part 2)

Counties	Assembly		Education		Retail		Food		Lodging		Office		Warehouse		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	MWh/yr	Therm/yr
ERCOT Counties																		
(square feet in thousands)																		
ANDERSON	-2150	2	-1168	1	-5352	2	187	0	-811	-3	-2439	1	2452	1	-9281	5	10	-54
ANDREWS	-1134	1	-6628	7	0	0	0	0	-1531	-5	-4602	2	0	0	-13896	5	15	-53
ANGELINA	-56580	57	-62498	63	-118619	55	4149	-7	-14834	-48	-44586	21	14620	6	-278347	146	298	-1564
ARANSAS	-6747	7	-1647	2	-68998	32	2413	-4	-3379	-11	-10156	5	422	0	-88091	30	94	-323
ARCHER	-2097	2	-20182	20	0	0	0	0	-2087	-7	-6273	3	4521	2	-26117	20	28	-219
ATASCOSA	-19283	19	-24756	25	-29500	14	1032	-2	-4511	-15	-13559	6	4530	2	-86047	50	92	-532
AUSTIN	-945	1	-44521	45	-2040	1	71	0	-2330	-8	-7004	3	421751	179	364982	221	-391	-2364
BANDERA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bastrop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAYLOR	0	0	-1543	2	0	0	0	0	-1112	-4	-3341	2	0	0	-5996	-1	6	6
BEE	-32314	32	-57622	58	-14341	7	502	-1	-10864	-36	-32655	15	476	0	-146818	76	157	-815
BELL	-131879	132	-303492	306	-229741	107	8036	-14	-166484	-544	-500397	231	255877	108	-1068079	327	1143	-3500
Bexar	-902452	905	-2099430	2119	-2982810	1392	104334	-186	-614177	-2007	-1846020	853	1963188	832	-6377367	3908	6824	-41821
BLANCO	-238	0	-20789	21	0	0	0	0	0	0	0	0	0	0	-21027	21	22	-227
BORDEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOSQUE	-1586	2	-19018	19	0	0	0	0	0	0	0	0	0	0	-20605	21	22	-222
Brazoria	-159072	159	-431167	435	-620030	289	21688	-39	-29302	-96	-88071	41	250498	106	-1055457	897	1129	-9594
BRAZOS	-253877	255	-345388	349	-276219	129	9662	-17	-106712	-349	-320741	148	117896	50	-1175379	564	1258	-6039
BREWSTER	-7455	7	-12603	13	0	0	0	0	-2917	-10	-8769	4	12051	5	-19694	20	21	-212
BRISCOE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BROOKS	-303	0	0	0	-1241	1	43	0	-83	0	-250	0	0	0	-1834	1	2	-7
BROWN	-9224	9	-17450	18	-20190	9	706	-1	-6302	-21	-18943	9	13528	6	-57875	29	62	-309
BURLESON	-1943	2	-13966	14	-1338	1	47	0	-1254	-4	-3771	2	0	0	-22225	14	24	-152
BURNET	-11477	12	-60184	61	-26484	12	926	-2	-4668	-15	-14031	6	5259	2	-110659	76	118	-818
Caldw ell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CALHOUN	-76	0	-13049	13	-47638	22	1666	-3	-535	-2	-1607	1	411	0	-60827	32	65	-339
CALLAHAN	-4758	5	-20645	21	-633	0	22	0	0	0	0	0	2718	1	-23296	27	25	-289
CAMERON	-135652	136	-459744	464	-440694	206	15415	-27	-109801	-359	-330026	153	648076	275	-812425	847	869	-9059
Chambers	-11534	12	-39471	40	-13538	6	474	-1	0	0	0	0	0	0	-64070	57	69	-609
CHEROKEE	-62075	62	-65944	67	-25234	12	883	-2	-13471	-44	-40488	19	73113	31	-133216	145	143	-1548
CHILDRESS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLAY	-634	1	-3901	4	0	0	0	0	0	0	0	0	0	0	-4536	5	5	-49
COKE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COLEMAN	-1483	1	-1742	2	-383	0	13	0	-357	-1	-1074	0	0	0	-5026	3	5	-29
Collin	-779172	781	-1148359	1159	-2955535	1380	103380	-184	-248728	-813	-747597	346	1063269	450	-4712742	3119	5043	-33375
COLORADO	0	0	-19980	20	-588	0	21	0	-1919	-6	-5767	3	257	0	-27978	17	30	-181
Comal	-42152	42	-170367	172	-185714	87	6496	-12	-23932	-78	-71931	33	59932	25	-427668	270	458	-2887
COMANCHE	-11824	12	-42845	43	-2773	1	97	0	-36687	-120	-110268	51	3412	1	-200888	-11	215	120
CONCHO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COOKE	-36458	37	-89747	91	-130995	61	4582	-8	-33819	-111	-101650	47	42249	18	-345838	135	370	-1439
CORYELL	-22121	22	-41084	41	-49923	23	1746	-3	-8393	-27	-25226	12	15178	6	-129822	75	139	-797
COTTLE	0	0	-1796	2	0	0	0	0	0	0	0	0	0	0	-1796	2	2	-19
CRANE	-2542	3	-1713	2	0	0	0	0	0	0	0	0	0	0	-4255	4	5	-46
CROCKETT	-5078	5	-1902	2	0	0	0	0	0	0	0	0	0	0	-6980	7	7	-75
CROSBY	-1211	1	-254	0	0	0	0	0	-350	-1	-1053	0	0	0	-2868	1	3	-9
CULBERSON	-1154	1	-9818	10	-973	0	34	0	0	0	0	0	0	0	-11910	11	13	-123
Dallas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAWSON	-675	1	-7924	8	0	0	0	0	0	0	0	0	0	0	-8599	9	9	-93
DE WITT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DELTA	-389	0	-3106	3	0	0	0	0	0	0	0	0	0	0	-3496	4	4	-38
Denton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DIMMIT	0	0	-3081	3	0	0	0	0	0	0	0	0	0	0	-3081	3	3	-33
DUVAL	-361	0	-24087	24	-2054	1	72	0	-48	0	-145	0	0	0	-26622	25	28	-272
EASTLAND	-12110	12	-4438	4	-51803	24	1812	-3	-316	-1	-949	0	0	0	-67804	37	73	-396
ECTOR	-47117	47	-108901	110	-99613	47	3484	-6	-64063	-209	-192554	89	474740	201	-34024	278	36	-2977
EDWARDS	-260	0	-549	1	0	0	0	0	0	0	0	0	0	0	-809	1	1	-9
Ellis	-77707	78	-137676	139	-164022	77	5737	-10	-10953	-36	-32920	15	650746	276	233205	538	-250	-5760
ERATH	-7131	7	-36508	37	-6300	3	220	0	-3955	-13	-11888	5	3529	1	-62033	41	66	-435
FALLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FANNIN	-9588	10	-24042	24	-8047	4	281	-1	-2007	-7	-6032	3	9813	4	-39623	38	42	-401
FAYETTE	-3567	4	-16585	17	-7462	3	261	0	-7695	-25	-23129	11	1338	1	-56840	9	61	-101
FISHER	0	0	-4004	4	0	0	0	0	-1023	-3	-3075	1	0	0	-8103	2	9	-23
FOARD	-301	0	0	0	0	0	0	0	0	0	0	0	0	0	-301	0	0	-3
Fort Bend	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FRANKLIN	-657	1	0	0	0	0	0	0	-81	0	-242	0	57399	24	56419	25	-60	-266

Table 40: Calculated ASHRAE Standard 90.1-1989 and 1999 Annual Electricity and Natural Gas Savings (USDOE 2004). A decrease in energy use is negative (i.e., savings); a positive value represents an energy use increase (+) (Part 3)

Counties	Assembly		Education		Retail		Food		Lodging		Office		Warehouse		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	MWh/yr	Therm/yr
ERCOT Counties																		
(square feet in thousands)																		
FREESTONE	0	0	-9785	10	0	0	0	0	-259	-1	-778	0	38	0	-10783	9	12	-101
FRIO	-847	1	-18332	19	-9886	5	346	-1	-1179	-4	-3544	2	0	0	-33443	21	36	-226
Galveston	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GILLESPIE	-12786	13	-6501	7	-32916	15	1151	-2	-3517	-11	-10572	5	11295	5	-53846	31	58	-330
GLASSCOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GOLIAD	0	0	-5151	5	0	0	0	0	0	0	0	0	0	0	-5151	5	6	-56
GONZALES	-836	1	-4629	5	-2312	1	81	0	-811	-3	-2438	1	0	0	-10946	5	12	-53
GRAYSON	-43152	43	-132934	134	-113449	53	3968	-7	-17688	-58	-53164	25	195832	83	-160586	273	172	-2922
GRIMES	-5044	5	-8986	9	0	0	0	0	0	0	0	0	0	0	-14029	14	15	-151
Guadalupe	-35372	35	-165551	167	-180728	84	6322	-11	-19261	-63	-57891	27	308512	131	-143971	370	154	-3961
HALL	0	0	-634	1	0	0	0	0	0	0	0	0	0	0	-634	1	1	-7
HAMILTON	-577	1	-6883	7	0	0	0	0	-1825	-6	-5486	3	0	0	-14771	4	16	-44
HARDEMAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harris	-2414134	2420	-3477000	3510	-6167773	2879	215739	-384	-839116	-2742	-2522114	1166	10408002	4409	-4796395	11257	5132	-120455
HASKELL	-288	0	0	0	-22502	11	787	-1	0	0	0	0	0	0	-22004	9	24	-101
Hays	-126555	127	-257771	260	-315566	147	11038	-20	-30150	-99	-90622	42	140435	59	-669191	518	716	-5538
Henderson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HIDALGO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HILL	-7095	7	-58053	59	-18190	8	636	-1	-1500	-5	-4510	2	0	0	-88712	70	95	-752
Hood	-57855	58	-72923	74	-32491	15	1136	-2	-3199	-10	-9615	4	0	0	-174946	139	187	-1485
HOPKINS	-8527	9	-19577	20	-26658	12	932	-2	-2794	-9	-8399	4	26062	11	-38961	45	42	-480
HOUSTON	-3125	3	-6431	6	-45275	21	1584	-3	-3556	-12	-10688	5	436	0	-67055	21	72	-229
HOWARD	-7098	7	-11906	12	-2867	1	100	0	-2713	-9	-8156	4	0	0	-32640	15	35	-163
HUDSPETH	-1103	1	-10233	10	0	0	0	0	0	0	0	0	0	0	-11336	11	12	-122
Hunt	-28029	28	-94365	95	-36490	17	1276	-2	-6640	-22	-19958	9	22898	10	-161308	135	173	-1448
IRION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JACK	-2163	2	-1120	1	0	0	0	0	0	0	0	0	0	0	-3283	3	4	-35
JACKSON	-2296	2	-18895	19	-1508	1	53	0	0	0	0	0	655	0	-21991	22	24	-238
JEFF DAVIS	-10753	11	-169	0	0	0	0	0	0	0	0	0	0	0	-10922	11	12	-117
JIM HOGG	-726	1	-9743	10	0	0	0	0	-465	-2	-1398	1	0	0	-12333	10	13	-104
JIM WELLS	-363	0	-55768	56	-56338	26	1971	-4	-11585	-38	-34821	16	8132	3	-148773	61	159	-654
Johnson	-15983	16	-157714	159	-133583	62	4673	-8	-2200	-7	-6612	3	138541	59	-172878	284	185	-3037
JONES	-13723	14	-9954	10	0	0	0	0	0	0	0	0	8251	3	-15426	27	17	-292
KARNES	0	0	-7903	8	-290	0	10	0	-718	-2	-2157	1	0	0	-11058	7	12	-72
Kaufman	-33385	33	-139599	141	-74480	35	2605	-5	-2751	-9	-8269	4	171035	72	-84843	272	91	-2908
KENDALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENEDY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0	-1228	-4	-3690	2	0	0	-4918	-2	5	25
KERR	-72102	72	-58423	59	-59011	28	2064	-4	-27158	-89	-81628	38	833	0	-295425	104	316	-1118
KIMBLE	-2740	3	-317	0	0	0	0	0	0	0	0	0	0	0	-3057	3	3	-33
KING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KINNEY	0	0	-3625	4	-1155	1	40	0	0	0	0	0	0	0	-4740	4	5	-44
KLEBERG	-9945	10	-44859	45	-85157	40	2979	-5	-4173	-14	-12544	6	2036	1	-151664	83	162	-885
KNOX	-1442	1	-1479	1	0	0	0	0	0	0	0	0	0	0	-2921	3	3	-31
LA SALLE	0	0	-1465	1	-1046	0	37	0	-769	-3	-2311	1	0	0	-5555	0	6	-5
LAMAR	-6829	7	-33650	34	-13147	6	460	-1	-1065	-3	-3201	1	3329	1	-54103	46	58	-487
LAMPASAS	-3012	3	-11001	11	-30602	14	1070	-2	-3401	-11	-10222	5	0	0	-57167	20	61	-215
LAVACA	-11927	12	-2412	2	-369	0	13	0	-397	-1	-1193	1	0	0	-16285	14	17	-148
LEE	-1175	1	-15543	16	-2360	1	83	0	0	0	0	0	1029	0	-17966	18	19	-195
LEON	-11639	12	-7876	8	0	0	0	0	0	0	0	0	119	0	-19395	20	21	-210
LIMESTONE	-4826	5	-6229	6	-23830	11	834	-1	-1790	-6	-5379	2	1065	0	-40155	18	43	-191
LIVE OAK	-17650	18	0	0	0	0	0	0	0	0	0	0	0	0	-17650	18	19	-189
LLANO	-1000	1	-28529	29	0	0	0	0	-28724	-94	-86334	40	71	0	-144516	-24	155	258
LOVING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MADISON	-934	1	-11636	12	-162	0	6	0	0	0	0	0	159	0	-12568	13	13	-137
MARTIN	0	0	-528	1	0	0	0	0	0	0	0	0	0	0	-528	1	1	-6
MASON	0	0	-1310	1	0	0	0	0	0	0	0	0	0	0	-1310	1	1	-14
MATAGORDA	-6290	6	-30532	31	-12064	6	422	-1	-4345	-14	-13058	6	14873	6	-50994	40	55	-430
MAVERICK	-21333	21	-47927	48	-30566	14	1069	-2	-14399	-47	-43277	20	1167	0	-155266	56	166	-595
MCCULLOCH	-681	1	-11198	11	0	0	0	0	0	0	0	0	0	0	-11879	12	13	-128
MCLENNAN	-119979	120	-313073	316	-259498	121	9077	-16	-62214	-203	-186997	86	262866	111	-669819	536	717	-5733
MCMULLEN	-3702	4	-740	1	0	0	0	0	0	0	0	0	0	0	-4442	4	5	-48
MEDINA	-5595	6	-23686	24	-2212	1	77	0	-36	0	-107	0	1484	1	-30074	31	32	-331
MENARD	-575	1	-1396	1	0	0	0	0	-118	0	-356	0	0	0	-2445	2	3	-19
MIDLAND	-149008	149	-69213	70	-232410	108	8129	-14	-25899	-85	-77844	36	38905	16	-507339	281	543	-3008
MILAM	-4614	5	-45724	46	-25752	12	901	-2	0	0	0	0	0	0	-75189	61	80	-655
MILLS	-2780	3	-9441	10	0	0	0	0	0	0	0	0	0	0	-12222	12	13	-132
MITCHELL	-6124	6	-180	0	-547	0	19	0	-2631	-9	-7908	4	0	0	-17371	2	19	-17
MONTAGUE	-2135	2	-14881	15	-25593	12	895	-2	-3105	-10	-9332	4	1634	1	-52516	22	56	-239
Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOTLEY	0	0	-750	1	0	0	0	0	0	0	0	0	0	0	-750	1	1	-8

Table 41: Calculated ASHRAE Standard 90.1-1989 and 1999 Annual Electricity and Natural Gas Savings (USDOE 2004). A decrease in energy use is negative (i.e., savings); a positive value represents an energy use increase (+) (Part 4)

Counties	Assembly		Education		Retail		Food		Lodging		Office		Warehouse		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	MWh/yr	Therm/yr
ERCOT Counties																		
(square feet in thousands)																		
NACOGDOCHES	-36751	37	-138086	139	-49579	23	1734	-3	-13773	-45	-41398	19	29160	12	-248692	183	266	-1956
NAVARRO	-5335	5	-35189	36	-46458	22	1625	-3	-7013	-23	-21078	10	73661	31	-39787	78	43	-831
NOLAN	-9440	9	-20285	20	-26859	13	939	-2	-4044	-13	-12156	6	0	0	-71844	33	77	-355
Nueces	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PALO PINTO	-7290	7	-30483	31	-37914	18	1326	-2	-1336	-4	-4015	2	3284	1	-76427	52	82	-560
Parker	-16167	16	-153399	155	-184395	86	6450	-11	-19010	-62	-57138	26	13772	6	-409888	216	439	-2309
PECOS	-5468	5	-7271	7	-889	0	31	0	-4833	-16	-14527	7	0	0	-32956	4	35	-44
PRESIDIO	-4357	4	-5689	6	0	0	0	0	0	0	0	0	634	0	-9412	10	10	-111
RAINS	-1033	1	-9497	10	0	0	0	0	0	0	0	0	0	0	-10530	11	11	-114
REAGAN	-2403	2	0	0	0	0	0	0	-183	-1	-549	0	0	0	-3135	2	3	-22
REAL	-764	1	-676	1	0	0	0	0	-1861	-6	-5595	3	873	0	-8024	-2	9	18
RED RIVER	-2773	3	-16155	16	-176	0	6	0	0	0	0	0	0	0	-19098	19	20	-205
REEVES	-8283	8	-2272	2	-1284	1	45	0	-2062	-7	-6196	3	0	0	-20051	7	21	-78
REFUGIO	-1847	2	-900	1	0	0	0	0	0	0	0	0	0	0	-2747	3	3	-30
ROBERTSON	-2221	2	-3632	4	0	0	0	0	-704	-2	-2115	1	2632	1	-6038	6	6	-61
Rockwall	-44818	45	-185932	188	-249258	116	8719	-16	-7833	-26	-23543	11	79209	34	-423457	352	453	-3769
RUNNELS	0	0	-7100	7	-2007	1	70	0	0	0	0	0	0	0	-9037	8	10	-85
Rusk	-976	1	-7186	7	-27959	13	978	-2	-456	-1	-1371	1	5213	2	-31757	21	34	-224
San Patricio	-22547	23	-66467	67	-59654	28	2087	-4	-9866	-32	-29655	14	523371	222	337268	317	-361	-3392
SAN SABA	-7238	7	-3170	3	-1900	1	66	0	0	0	0	0	0	0	-12241	11	13	-120
SCHLEICHER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCURRY	-915	1	-296	0	-10583	5	370	-1	-1184	-4	-3558	2	25395	11	9229	14	-10	-150
SHACKELFORD	-3043	3	-4607	5	0	0	0	0	-1138	-4	-3421	2	0	0	-12208	6	13	-60
Smith	-135104	135	-133779	135	-226989	106	7940	-14	-61511	-201	-184884	85	318587	135	-415740	382	445	-4084
SOMERVELL	-428	0	-7935	8	-409	0	14	0	-305	-1	-917	0	1974	1	-8007	9	9	-95
STARR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STEPHENS	0	0	-7057	7	0	0	0	0	-586	-2	-1761	1	0	0	-9404	6	10	-64
STERLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUTTON	0	0	-1955	2	0	0	0	0	-580	-2	-1742	1	0	0	-4277	1	5	-9
Tarrant	-1249901	1253	-1843420	1861	-4355546	2033	152350	-271	-512419	-1674	-1540168	712	4073254	1725	-5275849	5639	5645	-60334
TAYLOR	-57246	57	-57969	59	-208220	97	7283	-13	-30408	-99	-91396	42	112349	48	-325606	191	348	-2040
TERRELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THROCKMORTON	-1730	2	0	0	0	0	0	0	0	0	0	0	0	0	-1730	2	2	-19
TITUS	-7356	7	-30341	31	-17772	8	622	-1	-53	0	-160	0	0	0	-55060	45	59	-482
TOM GREEN	-103324	104	-104472	105	-135256	63	4731	-8	-57327	-187	-172305	80	71284	30	-496670	186	531	-1993
Travis	-533636	535	-618499	624	-1687838	788	59038	-105	-333374	-1089	-1002017	463	864659	366	-3251666	1582	3479	-16929
UPTON	0	0	0	0	0	0	0	0	-70	0	-210	0	0	0	-279	0	0	1
UVALDE	-23502	24	-38309	39	-86389	40	3022	-5	-2491	-8	-7488	3	17127	7	-138030	100	148	-1067
VAL VERDE	-14958	15	-34349	35	-18599	9	651	-1	-4377	-14	-13156	6	7102	3	-77686	52	83	-556
VAN ZANDT	-2449	2	-47976	48	-393	0	14	0	-106	0	-318	0	619	0	-50611	51	54	-547
Victoria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waller	-5302	5	-13845	14	-1302	1	46	0	0	0	0	0	29547	13	9143	32	-10	-346
WARD	0	0	0	0	0	0	0	0	0	0	0	0	148	0	148	0	0	-1
WASHINGTON	-51085	51	-42348	43	-86960	41	3042	-5	-5887	-19	-17695	8	54454	23	-146479	141	157	-1510
WEBB	-47062	47	-324000	327	-139636	65	4884	-9	-48648	-159	-146219	68	256530	109	-444151	448	475	-4794
WHARTON	-15549	16	-18741	19	-77288	36	2703	-5	-3265	-11	-9814	5	24551	10	-97403	70	104	-749
WICHITA	-100171	100	-59081	60	-132102	62	4621	-8	-84492	-276	-253956	117	60621	26	-564561	80	604	-861
WILBARGER	-5209	5	-8104	8	-22537	11	788	-1	-5656	-18	-17001	8	3112	1	-54607	13	58	-141
WILLACY	-3192	3	-49448	50	-69384	32	2427	-4	-651	-2	-1957	1	15593	7	-106611	87	114	-926
Williamson	-197427	198	-470404	475	-797344	372	27890	-50	-62738	-205	-188569	87	258145	109	-1430447	987	1531	-10559
Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WINKLER	-1480	1	-268	0	0	0	0	0	0	0	0	0	0	0	-1748	2	2	-19
WISE	-30957	31	-85603	86	-2527	1	88	0	-24133	-79	-72537	34	121	0	-215549	73	231	-783
YOUNG	-16710	17	-24385	25	-58912	28	2061	-4	-3170	-10	-9527	4	3401	1	-107241	61	115	-649
ZAPATA	-3749	4	-47523	48	-2054	1	72	0	-707	-2	-2125	1	0	0	-56086	51	60	-548
ZAVALA	-209	0	-5382	5	0	0	0	0	-611	-2	-1837	1	464	0	-7575	5	8	-50
Total	-8969811	8992	-16386931	16541	-25495977	11902	891810	-1588	-3993729	-13051	-12003878	5548	24873791	10536	-41084725	38882	43961	-416037

Table 42: Calculated ASHRAE Standard 90.1-1989 and 1999 OSD Electricity and Natural Gas Savings (USDOE 2004). A decrease in energy use is negative (i.e., savings); a positive value represents an energy use increase (+) (Part 1)

Counties	Assembly		Education		Retail		Food		Lodging		Office		Warehouse		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	MWh/yr	Therm/yr
Non-attainment Counties																		
(square feet in thousands)																		
Brazoria	-813	-3	-2064	-6	-2692	-1	-272	-2	-223	-1	-524	0	733	-1	-5855	-14	6	146
Chambers	-59	0	-189	-1	-59	0	-6	0	0	0	-98	0	0	0	-410	-1	0	9
Collin	-3980	-13	-5497	-16	-12833	-3	-1298	-10	-1897	-8	-5143	-3	3112	-3	-27535	-58	29	617
Dallas	-7875	-26	-9980	-29	-14558	-4	-1472	-11	-3370	-15	-15219	-10	18501	-20	-33974	-115	36	1234
Denton	-2834	-9	-5875	-17	-7048	-2	-713	-5	-1491	-7	-2369	-1	4816	-5	-15514	-47	17	507
El Paso	-2552	-8	-4211	-12	-3894	-1	-394	-3	-1168	-5	-3474	-2	7093	-8	-8600	-40	9	428
Fort Bend	-1824	-6	-3078	-9	-5156	-1	-521	-4	-711	-3	-2612	-2	3074	-3	-10828	-29	12	306
Galveston	-727	-2	-1111	-3	-1962	0	-198	-2	-414	-2	-1307	-1	393	0	-5328	-11	6	116
Hardin	-54	0	-215	-1	-149	0	-15	0	0	0	-10	0	0	0	-443	-1	0	10
Harris	-12331	-41	-16643	-49	-26781	-7	-2708	-21	-6399	-28	-18018	-11	30465	-33	-52415	-191	56	2040
Jefferson	-764	-3	-663	-2	-1874	0	-189	-1	-956	-4	-771	0	303	0	-4914	-11	5	123
Liberty	-41	0	-962	-3	-148	0	-15	0	-22	0	-116	0	15	0	-1289	-3	1	35
Montgomery	-1523	-5	-2689	-8	-4630	-1	-468	-4	-762	-3	-2416	-2	1300	-1	-11188	-24	12	258
Orange	-96	0	-601	-2	-198	0	-20	0	-75	0	-134	0	94	0	-1030	-3	1	30
Tarrant	-6384	-21	-8824	-26	-18912	-5	-1912	-15	-3908	-17	-6792	-4	11923	-13	-34810	-101	37	1085
Waller	-27	0	-66	0	-6	0	-1	0	0	0	-3	0	86	0	-16	0	0	4
Total (Non-attainment)	-41885	-138	-62667	-185	-100900	-26	-10203	-79	-21396	-95	-59006	-37	81908	-90	-214148	-649	229	6949
Affected Counties																		
(square feet in thousands)																		
Bastrop	-47	0	-298	-1	-184	0	-19	0	-175	-1	-45	0	39	0	-729	-2	1	22
Bexar	-4610	-15	-10049	-30	-12952	-3	-1310	-10	-4684	-21	-6672	-4	5746	-6	-34529	-90	37	958
Caldwell	-18	0	-336	-1	-137	0	-14	0	-22	0	-12	0	71	0	-468	-1	1	15
Comal	-215	-1	-815	-2	-806	0	-82	-1	-183	-1	-388	0	175	0	-2314	-5	2	56
Ellis	-397	-1	-659	-2	-712	0	-72	-1	-84	0	-192	0	1905	-2	-211	-7	0	70
Gregg	-416	-1	-189	-1	-508	0	-51	0	-313	-1	-191	0	270	0	-1399	-4	1	46
Guadalupe	-181	-1	-792	-2	-785	0	-79	-1	-147	-1	-494	0	903	-1	-1575	-6	2	61
Harrison	-342	-1	-345	-1	-364	0	-37	0	-128	-1	-95	0	63	0	-1248	-3	1	34
Hays	-646	-2	-1234	-4	-1370	0	-139	-1	-230	-1	-1030	-1	411	0	-4238	-9	5	100
Henderson	-37	0	-119	0	-101	0	-10	0	-9	0	-20	0	110	0	-186	-1	0	8
Hood	-296	-1	-349	-1	-141	0	-14	0	-24	0	-79	0	0	0	-903	-2	1	25
Hunt	-143	0	-452	-1	-158	0	-16	0	-51	0	-132	0	67	0	-885	-2	1	25
Johnson	-82	0	-755	-2	-580	0	-59	0	-17	0	-61	0	406	0	-1147	-4	1	39
Kaufman	-171	-1	-668	-2	-323	0	-33	0	-21	0	-110	0	501	-1	-825	-4	1	38
Nueces	-879	-3	-849	-3	-794	0	-80	-1	-631	-3	-915	-1	786	-1	-3362	-10	4	112
Parker	-83	0	-734	-2	-801	0	-81	-1	-145	-1	-62	0	40	0	-1865	-4	2	43
Rockwall	-229	-1	-890	-3	-1082	0	-109	-1	-60	0	-196	0	232	0	-2335	-5	2	55
Rusk	-5	0	-34	0	-121	0	-12	0	-3	0	-18	0	15	0	-179	0	0	3
San Patricio	-115	0	-318	-1	-259	0	-26	0	-75	0	-565	0	1532	-2	173	-4	0	42
Smith	-690	-2	-640	-2	-986	0	-100	-1	-469	-2	-913	-1	933	-1	-2866	-9	3	95
Travis	-2726	-9	-2960	-9	-7329	-2	-741	-6	-2542	-11	-3970	-2	2531	-3	-17737	-42	19	448
Upshur	-94	0	-163	0	-43	0	-4	0	-8	0	-38	0	12	0	-338	-1	0	10
Victoria	-147	0	-91	0	-332	0	-34	0	-77	0	-129	0	62	0	-748	-2	1	17
Williamson	-1008	-3	-2252	-7	-3462	-1	-350	-3	-478	-2	-1012	-1	756	-1	-7807	-17	8	183
Wilson	-19	0	-135	0	-53	0	-5	0	-37	0	-2	0	0	0	-252	-1	0	7
Total (Affected)	-13596	-45	-26128	-77	-34385	-9	-3477	-27	-10612	-47	-17343	-11	17566	-19	-87974	-235	94	2512

Table 43: Calculated ASHRAE Standard 90.1-1989 and 1999 OSD Electricity and Natural Gas Savings (USDOE 2004). A decrease in energy use is negative (i.e., savings); a positive value represents an energy use increase (+) (Part 2)

Counties	Assembly		Education		Retail		Food		Lodging		Office		Warehouse		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	MWh/yr	Therm/yr
ERCOT Counties																		
(square feet in thousands)																		
ANDERSON	-11	0	-6	0	-23	0	-2	0	-6	0	-12	0	7	0	-53	0	0	1
ANDREWS	-6	0	-32	0	0	0	0	0	-12	0	-23	0	0	0	-72	0	0	2
ANGELINA	-289	-1	-299	-1	-515	0	-52	0	-113	-1	-219	0	43	0	-1444	-3	2	33
ARANSAS	-34	0	-8	0	-300	0	-30	0	-26	0	-50	0	1	0	-447	-1	0	6
ARCHER	-11	0	-97	0	0	0	0	0	-16	0	-31	0	13	0	-141	0	0	5
ATASCOSA	-98	0	-118	0	-128	0	-13	0	-34	0	-66	0	13	0	-446	-1	0	11
AUSTIN	-5	0	-213	-1	-9	0	-1	0	-18	0	-34	0	1234	-1	955	-2	-1	23
BANDERA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bastrop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAYLOR	0	0	-7	0	0	0	0	0	-8	0	-16	0	0	0	-32	0	0	1
BEE	-165	-1	-276	-1	-62	0	-6	0	-83	0	-160	0	1	0	-751	-2	1	20
BELL	-674	-2	-1453	-4	-998	0	-101	-1	-1270	-6	-2454	-2	749	-1	-6199	-16	7	166
Bexar	-4610	-15	-10049	-30	-12952	-3	-1310	-10	-4684	-21	-9053	-6	5746	-6	-36910	-91	39	974
BLANCO	-1	0	-100	0	0	0	0	0	0	0	0	0	0	0	-101	0	0	3
BORDEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOSQUE	-8	0	-91	0	0	0	0	0	0	0	0	0	0	0	-99	0	0	3
Brazoria	-813	-3	-2064	-6	-2692	-1	-272	-2	-223	-1	-432	0	733	-1	-5763	-14	6	146
BRAZOS	-1297	-4	-1653	-5	-1199	0	-121	-1	-814	-4	-1573	-1	345	0	-6312	-15	7	165
BREWSTER	-38	0	-60	0	0	0	0	0	-22	0	-43	0	35	0	-128	0	0	5
BRISCOE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BROOKS	-2	0	0	0	-5	0	-1	0	-1	0	-1	0	0	0	-9	0	0	0
BROWN	-47	0	-84	0	-88	0	-9	0	-48	0	-93	0	40	0	-329	-1	0	9
BURLESON	-10	0	-67	0	-6	0	-1	0	-10	0	-18	0	0	0	-111	0	0	3
BURNET	-59	0	-288	-1	-115	0	-12	0	-36	0	-69	0	15	0	-562	-1	1	15
Caldw ell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CALHOUN	0	0	-62	0	-207	0	-21	0	-4	0	-8	0	1	0	-301	0	0	5
CALLAHAN	-24	0	-99	0	-3	0	0	0	0	0	0	0	8	0	-118	0	0	4
CAMERON	-693	-2	-2201	-6	-1914	0	-193	-1	-837	-4	-1618	-1	1897	-2	-5559	-18	6	188
Chambers	-59	0	-189	-1	-59	0	-6	0	0	0	0	0	0	0	-313	-1	0	9
CHEROKEE	-317	-1	-316	-1	-110	0	-11	0	-103	0	-199	0	214	0	-841	-3	1	31
CHILDRESS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLAY	-3	0	-19	0	0	0	0	0	0	0	0	0	0	0	-22	0	0	1
COKE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COLEMAN	-8	0	-8	0	-2	0	0	0	-3	0	-5	0	0	0	-26	0	0	1
Collin	-3980	-13	-5497	-16	-12833	-3	-1298	-10	-1897	-8	-3666	-2	3112	-3	-26058	-57	28	607
COLORADO	0	0	-96	0	-3	0	0	0	-15	0	-28	0	1	0	-141	0	0	4
Comal	-215	-1	-815	-2	-806	0	-82	-1	-183	-1	-353	0	175	0	-2279	-5	2	55
COMANCHE	-60	0	-205	-1	-12	0	-1	0	-280	-1	-541	0	10	0	-1089	-2	1	26
CONCHO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COOKE	-186	-1	-430	-1	-569	0	-58	0	-258	-1	-498	0	124	0	-1875	-4	2	43
CORYELL	-113	0	-197	-1	-217	0	-22	0	-64	0	-124	0	44	0	-692	-2	1	17
COTTLE	0	0	-9	0	0	0	0	0	0	0	0	0	0	0	-9	0	0	0
CRANE	-13	0	-8	0	0	0	0	0	0	0	0	0	0	0	-21	0	0	1
CROCKETT	-26	0	-9	0	0	0	0	0	0	0	0	0	0	0	-35	0	0	1
CROSBY	-6	0	-1	0	0	0	0	0	-3	0	-5	0	0	0	-15	0	0	0
CULBERSON	-6	0	-47	0	-4	0	0	0	0	0	0	0	0	0	-58	0	0	2
Dallas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAWSON	-3	0	-38	0	0	0	0	0	0	0	0	0	0	0	-41	0	0	1
DE WITT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DELTA	-2	0	-15	0	0	0	0	0	0	0	0	0	0	0	-17	0	0	1
Denton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DIMMIT	0	0	-15	0	0	0	0	0	0	0	0	0	0	0	-15	0	0	0
DUVAL	-2	0	-115	0	-9	0	-1	0	0	0	-1	0	0	0	-128	0	0	4
EASTLAND	-62	0	-21	0	-225	0	-23	0	-2	0	-5	0	0	0	-338	-1	0	5
ECTOR	-241	-1	-521	-2	-433	0	-44	0	-489	-2	-944	-1	1390	-2	-1281	-7	1	76
EDWARDS	-1	0	-3	0	0	0	0	0	0	0	0	0	0	0	-4	0	0	0
Ellis	-397	-1	-659	-2	-712	0	-72	-1	-84	0	-161	0	1905	-2	-180	-7	0	70
ERATH	-36	0	-175	-1	-27	0	-3	0	-30	0	-58	0	10	0	-319	-1	0	9
FALLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FANNIN	-49	0	-115	0	-35	0	-4	0	-15	0	-30	0	29	0	-219	-1	0	7
FAYETTE	-18	0	-79	0	-32	0	-3	0	-59	0	-113	0	4	0	-301	-1	0	7
FISHER	0	0	-19	0	0	0	0	0	-8	0	-15	0	0	0	-42	0	0	1
FOARD	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Fort Bend	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FRANKLIN	-3	0	0	0	0	0	0	0	-1	0	-1	0	168	0	163	0	0	2

Table 44: Calculated ASHRAE Standard 90.1-1989 and 1999 OSD Electricity and Natural Gas Savings (USDOE 2004). A decrease in energy use is negative (i.e., savings); a positive value represents an energy use increase (+) (Part 3)

Counties	Assembly		Education		Retail		Food		Lodging		Office		Warehouse		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	MWh/yr	Therm/yr
ERCOT Counties																		
(square feet in thousands)																		
FREESTONE	0	0	-47	0	0	0	0	0	-2	0	-4	0	0	0	-53	0	0	2
FRIO	-4	0	-88	0	-43	0	-4	0	-9	0	-17	0	0	0	-166	0	0	4
Galveston	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GILLESPIE	-65	0	-31	0	-143	0	-14	0	-27	0	-52	0	33	0	-299	-1	0	7
GLASSCOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GOLIAD	0	0	-25	0	0	0	0	0	0	0	0	0	0	0	-25	0	0	1
GONZALES	-4	0	-22	0	-10	0	-1	0	-6	0	-12	0	0	0	-56	0	0	1
GRAYSON	-220	-1	-636	-2	-493	0	-50	0	-135	-1	-261	0	573	-1	-1222	-5	1	48
GRIMES	-26	0	-43	0	0	0	0	0	0	0	0	0	0	0	-69	0	0	2
Guadalupe	-181	-1	-792	-2	-785	0	-79	-1	-147	-1	-284	0	903	-1	-1365	-6	1	60
HALL	0	0	-3	0	0	0	0	0	0	0	0	0	0	0	-3	0	0	0
HAMILTON	-3	0	-33	0	0	0	0	0	-14	0	-27	0	0	0	-77	0	0	2
HARDEMAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harris	-12331	-41	-16643	-49	-26781	-7	-2708	-21	-6399	-28	-12368	-8	30465	-33	-46766	-187	50	2002
HASKELL	-1	0	0	0	-98	0	-10	0	0	0	0	0	0	0	-109	0	0	1
Hays	-646	-2	-1234	-4	-1370	0	-139	-1	-230	-1	-444	0	411	0	-3652	-9	4	96
Henderson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HIDALGO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HILL	-36	0	-278	-1	-79	0	-8	0	-11	0	-22	0	0	0	-435	-1	0	12
Hood	-296	-1	-349	-1	-141	0	-14	0	-24	0	-47	0	0	0	-871	-2	1	25
HOPKINS	-44	0	-94	0	-116	0	-12	0	-21	0	-41	0	76	0	-251	-1	0	8
HOUSTON	-16	0	-31	0	-197	0	-20	0	-27	0	-52	0	1	0	-341	-1	0	5
HOWARD	-36	0	-57	0	-12	0	-1	0	-21	0	-40	0	0	0	-168	0	0	4
HUDSPETH	-6	0	-49	0	0	0	0	0	0	0	0	0	0	0	-55	0	0	2
Hunt	-143	0	-452	-1	-158	0	-16	0	-51	0	-98	0	67	0	-851	-2	1	25
IRION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JACK	-11	0	-5	0	0	0	0	0	0	0	0	0	0	0	-16	0	0	1
JACKSON	-12	0	-90	0	-7	0	-1	0	0	0	0	0	2	0	-107	0	0	3
JEFF DAVIS	-55	0	-1	0	0	0	0	0	0	0	0	0	0	0	-56	0	0	2
JIM HOGG	-4	0	-47	0	0	0	0	0	-4	0	-7	0	0	0	-61	0	0	2
JIM WELLS	-2	0	-267	-1	-245	0	-25	0	-88	0	-171	0	24	0	-773	-2	1	17
Johnson	-82	0	-755	-2	-580	0	-59	0	-17	0	-32	0	406	0	-1119	-4	1	39
JONES	-70	0	-48	0	0	0	0	0	0	0	0	0	24	0	-94	0	0	4
KARNES	0	0	-38	0	-1	0	0	0	-5	0	-11	0	0	0	-55	0	0	2
Kaufman	-171	-1	-668	-2	-323	0	-33	0	-21	0	-41	0	501	-1	-756	-4	1	38
KENDALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENEDY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0	-9	0	-18	0	0	0	-27	0	0	1
KERR	-368	-1	-280	-1	-256	0	-26	0	-207	-1	-400	0	2	0	-1535	-3	2	37
KIMBLE	-14	0	-2	0	0	0	0	0	0	0	0	0	0	0	-16	0	0	1
KING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KINNEY	0	0	-17	0	-5	0	-1	0	0	0	0	0	0	0	-23	0	0	1
KLEBERG	-51	0	-215	-1	-370	0	-37	0	-32	0	-62	0	6	0	-760	-1	1	15
KNOX	-7	0	-7	0	0	0	0	0	0	0	0	0	0	0	-14	0	0	0
LA SALLE	0	0	-7	0	-5	0	0	0	-6	0	-11	0	0	0	-29	0	0	1
LAMAR	-35	0	-161	0	-57	0	-6	0	-8	0	-16	0	10	0	-273	-1	0	8
LAMPASAS	-15	0	-53	0	-133	0	-13	0	-26	0	-50	0	0	0	-290	0	0	5
LAVACA	-61	0	-12	0	-2	0	0	0	-3	0	-6	0	0	0	-83	0	0	3
LEE	-6	0	-74	0	-10	0	-1	0	0	0	0	0	3	0	-89	0	0	3
LEON	-59	0	-38	0	0	0	0	0	0	0	0	0	0	0	-97	0	0	3
LIMESTONE	-25	0	-30	0	-103	0	-10	0	-14	0	-26	0	3	0	-205	0	0	4
LIVE OAK	-90	0	0	0	0	0	0	0	0	0	0	0	0	0	-90	0	0	3
LLANO	-5	0	-137	0	0	0	0	0	-219	-1	-423	0	0	0	-784	-2	1	18
LOVING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MADISON	-5	0	-56	0	-1	0	0	0	0	0	0	0	0	0	-61	0	0	2
MARTIN	0	0	-3	0	0	0	0	0	0	0	0	0	0	0	-3	0	0	0
MASON	0	0	-6	0	0	0	0	0	0	0	0	0	0	0	-6	0	0	0
MATAGORDA	-32	0	-146	0	-52	0	-5	0	-33	0	-64	0	44	0	-290	-1	0	9
MAVERICK	-109	0	-229	-1	-133	0	-13	0	-110	0	-212	0	3	0	-803	-2	1	19
MCCULLOCH	-3	0	-54	0	0	0	0	0	0	0	0	0	0	0	-57	0	0	2
MCLENNAN	-613	-2	-1499	-4	-1127	0	-114	-1	-474	-2	-917	-1	769	-1	-3974	-11	4	119
MCMULLEN	-19	0	-4	0	0	0	0	0	0	0	0	0	0	0	-22	0	0	1
MEDINA	-29	0	-113	0	-10	0	-1	0	0	0	-1	0	4	0	-149	0	0	5
MENARD	-3	0	-7	0	0	0	0	0	-1	0	-2	0	0	0	-12	0	0	0
MIDLAND	-761	-3	-331	-1	-1009	0	-102	-1	-198	-1	-382	0	114	0	-2669	-6	3	62
MILAM	-24	0	-219	-1	-112	0	-11	0	0	0	0	0	0	0	-366	-1	0	9
MILLS	-14	0	-45	0	0	0	0	0	0	0	0	0	0	0	-59	0	0	2
MITCHELL	-31	0	-1	0	-2	0	0	0	-20	0	-39	0	0	0	-94	0	0	2
MONTAGUE	-11	0	-71	0	-111	0	-11	0	-24	0	-46	0	5	0	-269	-1	0	5
Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOTLEY	0	0	-4	0	0	0	0	0	0	0	0	0	0	0	-4	0	0	0

Table 45: Calculated ASHRAE Standard 90.1-1989 and 1999 OSD Electricity and Natural Gas Savings (USDOE 2004). A decrease in energy use is negative (i.e., savings); a positive value represents an energy use increase (+) (Part 4)

Counties	Assembly		Education		Retail		Food		Lodging		Office		Warehouse		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	kWh/yr	mBtu/yr	MWh/yr	Therm/yr
ERCOT Counties																		
(square feet in thousands)																		
NACOGDOCHES	-188	-1	-661	-2	-215	0	-22	0	-105	0	-203	0	85	0	-1308	-3	1	37
NAVARRO	-27	0	-168	0	-202	0	-20	0	-53	0	-103	0	216	0	-359	-1	0	14
NOLAN	-48	0	-97	0	-117	0	-12	0	-31	0	-60	0	0	0	-364	-1	0	8
Nueces	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PALO PINTO	-37	0	-146	0	-165	0	-17	0	-10	0	-20	0	10	0	-385	-1	0	8
Parker	-83	0	-734	-2	-801	0	-81	-1	-145	-1	-280	0	40	0	-2083	-4	2	44
PECOS	-28	0	-35	0	-4	0	0	0	-37	0	-71	0	0	0	-175	0	0	4
PRESIDIO	-22	0	-27	0	0	0	0	0	0	0	0	0	2	0	-48	0	0	2
RAINS	-5	0	-45	0	0	0	0	0	0	0	0	0	0	0	-51	0	0	2
REAGAN	-12	0	0	0	0	0	0	0	-1	0	-3	0	0	0	-16	0	0	1
REAL	-4	0	-3	0	0	0	0	0	-14	0	-27	0	3	0	-46	0	0	1
RED RIVER	-14	0	-77	0	-1	0	0	0	0	0	0	0	0	0	-92	0	0	3
REEVES	-42	0	-11	0	-6	0	-1	0	-16	0	-30	0	0	0	-105	0	0	3
REFUGIO	-9	0	-4	0	0	0	0	0	0	0	0	0	0	0	-14	0	0	0
ROBERTSON	-11	0	-17	0	0	0	0	0	-5	0	-10	0	8	0	-37	0	0	1
Rockw all	-229	-1	-890	-3	-1082	0	-109	-1	-60	0	-115	0	232	0	-2254	-5	2	54
RUNNELS	0	0	-34	0	-9	0	-1	0	0	0	0	0	0	0	-44	0	0	1
Rusk	-5	0	-34	0	-121	0	-12	0	-3	0	-7	0	15	0	-168	0	0	3
San Patricio	-115	0	-318	-1	-259	0	-26	0	-75	0	-145	0	1532	-2	593	-4	-1	40
SAN SABA	-37	0	-15	0	-8	0	-1	0	0	0	0	0	0	0	-61	0	0	2
SCHLEICHER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCURRY	-5	0	-1	0	-46	0	-5	0	-9	0	-17	0	74	0	-9	0	0	2
SHACKELFORD	-16	0	-22	0	0	0	0	0	-9	0	-17	0	0	0	-63	0	0	2
Smith	-690	-2	-640	-2	-986	0	-100	-1	-469	-2	-907	-1	933	-1	-2859	-9	3	95
SOMERVELL	-2	0	-38	0	-2	0	0	0	-2	0	-4	0	6	0	-43	0	0	2
STARR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STEPHENS	0	0	-34	0	0	0	0	0	-4	0	-9	0	0	0	-47	0	0	1
STERLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUTTON	0	0	-9	0	0	0	0	0	-4	0	-9	0	0	0	-22	0	0	1
Tarrant	-6384	-21	-8824	-26	-18912	-5	-1912	-15	-3908	-17	-7553	-5	11923	-13	-35571	-102	38	1090
TAYLOR	-292	-1	-277	-1	-904	0	-91	-1	-232	-1	-448	0	329	0	-1917	-4	2	47
TERRELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THROCKMORTON	-9	0	0	0	0	0	0	0	0	0	0	0	0	0	-9	0	0	0
TITUS	-38	0	-145	0	-77	0	-8	0	0	0	-1	0	0	0	-269	-1	0	7
TOM GREEN	-528	-2	-500	-1	-587	0	-59	0	-437	-2	-845	-1	209	0	-2748	-7	3	70
Travis	-2726	-9	-2960	-9	-7329	-2	-741	-6	-2542	-11	-4914	-3	2531	-3	-18681	-42	20	454
UPTON	0	0	0	0	0	0	0	0	-1	0	-1	0	0	0	-2	0	0	0
UVALDE	-120	0	-183	-1	-375	0	-38	0	-19	0	-37	0	50	0	-722	-1	1	16
VAL VERDE	-76	0	-164	0	-81	0	-8	0	-33	0	-65	0	21	0	-407	-1	0	11
VAN ZANDT	-13	0	-230	-1	-2	0	0	0	-1	0	-2	0	2	0	-245	-1	0	8
Victoria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waller	-27	0	-66	0	-6	0	-1	0	0	0	0	0	86	0	-13	0	0	4
WARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WASHINGTON	-261	-1	-203	-1	-378	0	-38	0	-45	0	-87	0	159	0	-852	-2	1	24
WEBB	-240	-1	-1551	-5	-606	0	-61	0	-371	-2	-717	0	751	-1	-2796	-9	3	95
WHARTON	-79	0	-90	0	-336	0	-34	0	-25	0	-48	0	72	0	-540	-1	1	12
WICHITA	-512	-2	-283	-1	-574	0	-58	0	-644	-3	-1245	-1	177	0	-3138	-7	3	74
WILBARGER	-27	0	-39	0	-98	0	-10	0	-43	0	-83	0	9	0	-291	-1	0	6
WILLACY	-16	0	-237	-1	-301	0	-30	0	-5	0	-10	0	46	0	-554	-1	1	12
Williamson	-1008	-3	-2252	-7	-3462	-1	-350	-3	-478	-2	-925	-1	756	-1	-7720	-17	8	183
Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WINKLER	-8	0	-1	0	0	0	0	0	0	0	0	0	0	0	-9	0	0	0
WISE	-158	-1	-410	-1	-11	0	-1	0	-184	-1	-356	0	0	0	-1119	-3	1	30
YOUNG	-85	0	-117	0	-256	0	-26	0	-24	0	-47	0	10	0	-545	-1	1	11
ZAPATA	-19	0	-227	-1	-9	0	-1	0	-5	0	-10	0	0	0	-272	-1	0	8
ZAVALA	-1	0	-26	0	0	0	0	0	-5	0	-9	0	1	0	-39	0	0	1
Total	-45817	-151	-78437	-231	-110706	-28	-11195	-86	-30456	-135	-58867	-37	72807	-80	-262670	-749	281	8016

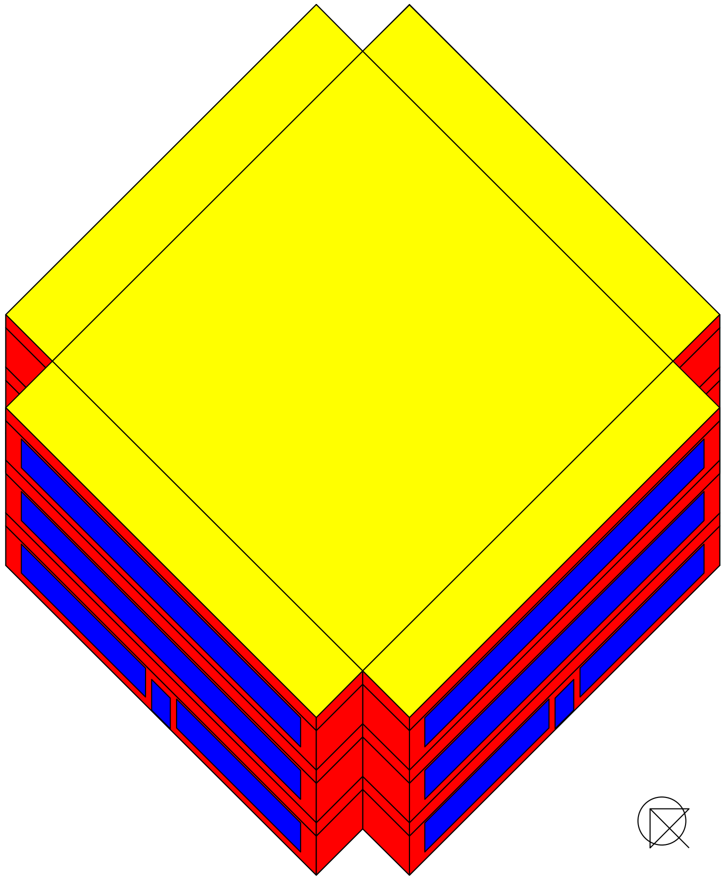


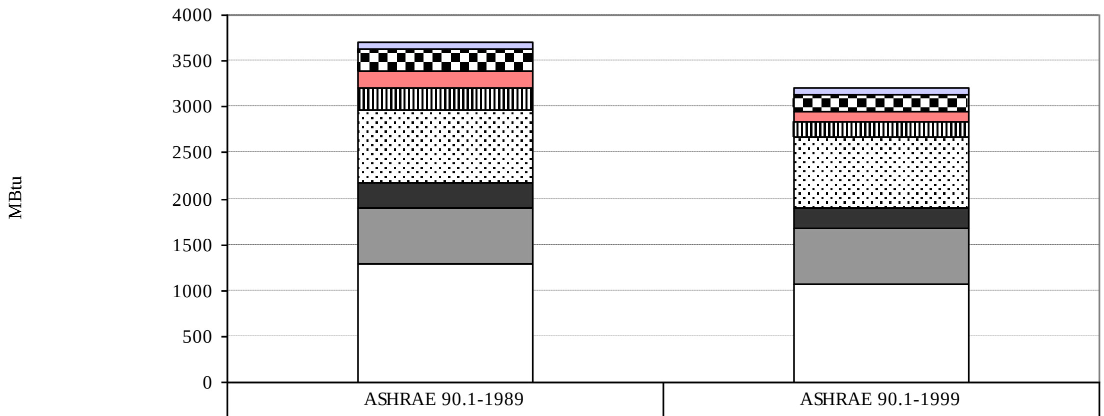
Figure 84: Typical Office Building Used for Annual to OSD calculation (3-story shown)

Table 46: Office/Retail Simulation Input Parameters (LOADS)

NAME	DESCRIPTION	DEFAULT	STATUS	COMMENT
LOADS				
b01	Quick or thermal mode (Q or T)	Quick (Q)	Fixed	Q simulates the building as massless, T will include thermal mass
b02	Location	Bastrop (BAS)	User Defined	41 counties linked to 9 TRY packed weather files according to climate zone
b03	Azimuth of building (degree)	0	User Defined	Orientation of the building
b04	Length of building (ft)	122	User Defined	
b05	Width of building (ft)	122	User Defined	
b06	Floor to ceiling height (ft)	9	User Defined	
b07	Door height (ft)	7	Fixed	
b08	Door width (ft)	6	Fixed	
b09	Run year	2000	User Defined	
b10	Floor to floor height (ft)	13	User Defined	This defines the plenum height in conjunction with b06
b11	Number of floor	6	User Defined	
b12	Perimeter depth (ft)	15	Fixed	Used for thermal zoning
b13	Void			
b14	Underground floor mode	No (N)	User Defined	This allows the user to activate/deactivate underground floors
b15	Front wall: Attached to another building?	No (N)	User Defined	These 4 parameters are used to attach buildings to the different orientations of the model for the retail scenario
b16	Right wall: Attached to another building?	No (N)	User Defined	
b17	Back wall: Attached to another building?	No (N)	User Defined	
b18	Left wall: Attached to another building?	No (N)	User Defined	
b19	Building type	Office (O)	User Defined	Allows the user to switch between Office and Retail
b20	Code compliance	Code (C)	User Defined	Allows user to run user defined model or either of ASHRAE 90.1 1989 or 1999
c01	Roof absorptance	0.45	User Defined	c01 and c03 are used to determine "roof color"
c02	Roof roughness	1	Fixed	This is used to calculate the outside film coefficient for heat transfer calculations, DOE-2 allows values from 1 to 6 increasing in smoothness
c03	Roof outside emissivity	0.89	User Defined	c01 and c03 are used to determine "roof color"
c04	Roof insulation R-value (hr-sq.ft-F/Btu)	R-15	User Defined	
c05	Wall absorptance	0.57	User Defined	c05 and c07 are used to define "wall color"
c06	Wall roughness	2	Fixed	This is used to calculate the outside film coefficient for heat transfer calculations, DOE-2 allows values from 1 to 6 increasing in smoothness
c07	Wall outside emissivity	0.9	User Defined	c05 and c07 are used to define "wall color"
c08	Wall insulation R-value (hr-sq.ft-F/Btu)	R-13	User Defined	
c09	Ground reflectance	0.24	Fixed	This defines the fraction of sunlight reflected from the ground
c10	Void			
c11	U-Factor of glazing (Btu/hr-sq.ft-F)	1.22	User Defined	
c12	Solar Heat Gain Coefficient(SHGC)	0.17	User Defined	
c13	Number of pane of glazing	1	Fixed	
c14	Frame absorptance of glazing	0.7	Fixed	
c15	Frame type - A,B,C,D,E	Aluminum w/o thermal break (A)	User Defined	Allows user to select from 5 different frame types
c16	Void			
c17	Floor weight (lb/sq-ft)	70	User Defined	This corresponds to medium construction, user has a choice of light, medium or heavy construction
c18	Slab-on-grade floor insulation R-value (Exterior insulation, horizontal) (hr-sq.ft-F/Btu)	R-0 (A)	User Defined	User can choose from 9 insulation R-values and insulation depths
c19	Slab-on-grade floor R-value (hr-sq.ft-F/Btu)	0.88	Fixed	
c20	Below-grade wall insulation R-value (hr-sq.ft-F/Btu) (Exterior insulation, vertical, basement wall = 8 ft)	R-0 (A)	User Defined	User can choose from 9 insulation R-values
c21	Below-grade wall R-value (concrete wall) (hr-sq.ft-F/Btu)	0.88	Fixed	
c22	Void			
c23	Floor R-value	1.67	Fixed	
c24	Void			
c25	Ceiling R-value (hr-sq.ft-F/Btu)	1.89	Fixed	
c26	Interior wall R-value (hr-sq.ft-F/Btu)	2.01	Fixed	
c27	Percent window-front (%)	50	User Defined	
c28	Percent window-right (%)	50	User Defined	
c29	Percent window-back (%)	50	User Defined	
c30	Percent window-left (%)	50	User Defined	
sp01	void			
sp02	void			
sp03	Area per person (ft^2/person) for office	275	User Defined	
sp04	Lighting load (W/ft2) for office	1.3	User Defined	
sp05	Equipment load (W/ft2) for office	0.75	User Defined	
sp06	Area per person (ft^2/person) for retail	300	User Defined	
sp07	Lighting load (W/ft2) for retail	1.9	User Defined	
sp08	Equipment load (W/ft2) for retail	0.25	User Defined	
s01	Front Shade (S)	0	User Defined	
s02	Back Shade (N)	0	User Defined	
s03	Left Shade (W)	0	User Defined	
s04	Right Shade (E)	0	User Defined	

Table 47: Office/Retail Simulation Input Parameters (SYSTEMS and PLANT)

NAME	DESCRIPTION	DEFAULT	STATUS	COMMENT
SYSTEM				
sy01	Mode of system	Variable air volume (2)	User Defined	User can choose from Packaged single zone, variable air volume or packaged variable volume system
sy02	Cooling Capacity of cooling system (Btu/hr)	0	Fixed	DOE-2 is autosizing the system
sy03	Heating Capacity of heating system (Btu/hr)	0	Fixed	DOE-2 is autosizing the system
sy04	Seasonal Energy Efficiency Ratio (SEER) for PVAVS and PSZ	10	User Defined	
sy05	ANNUAL FUEL UTILIZATION EFFICIENCY (AFUE) for PSZ	0.8	User Defined	
sy06	**Spare parameter for systems other than VAVS**HEATING SEASONAL PERFORMANCE FACTOR (HSPF)	6.8	User Defined	Unused, since heatpump systems are not included in the office/retail scenario
sy07	**Spare parameter for Pilot light	0	Fixed	Unused
sy08	**Spare parameter for Pilot light	0	Fixed	Unused
sy09	**Spare parameter for Pilot light	0	Fixed	Unused
sy10			Void	
sy11	Exterior lighting (kW)	0	Fixed	
sy12			Void	
sy13	Fan control type	Variable frequency drives (1)	User Defined	User can choose from 4 different type of fan control
sy14	Economizer type	None (1)	User Defined	
sy15	Economizer drybulb limit (F) (use when economizer type(sy14) = dry bulb(2))	65	Fixed	This corresponds to the temperature above which the outside air dampers return to the minimum position
sy16	User input for numbers of fans	Autosized (A)	Fixed	Autosized by DOE-2
sy17	Number of Fans	6	Fixed	equal to the number of floors
sy18	Supply fan total pressure (in W.G)	5.5	Fixed	
sy19	Supply fan efficiency	0.54	Fixed	
sy20	Return fan total pressure (in W.G)	2	Fixed	
sy21	Return fan efficiency	0.51	Fixed	
sy22	Supply motor efficiency	0.5	Fixed	
sy23	Return motor efficiency	0.5	Fixed	
sy24	User input for DHW gallon/hr-person	Autosized (A)	Fixed	The size of DHW depends on the gallons per hour per person requirements of ASHRAE 90.1
sy25	Maximum DHW gallon/h-person (maximum hourly, to be used with occupancy schedule)	0.4	Fixed	
PLANT				
p01	Chiller type	Electric Centrifugal (1)	Fixed	
p02	Number of chillers	1	Fixed	
p03	Chillers size (MBtu/h)	-999	Fixed	Chiller is being autosized by DOE-2
p04	Condenser type	water-cooled (W)	Fixed	
p05	COP	5	User Defined	
p06	Switch for a chiller sizing	Autosized (A)	Fixed	Chiller is being autosized by DOE-2
p07	Cooling tower type	Open tower (O)		
p08			Void	
p09	Gpm/hp	38.2	Fixed	Value from ASHRAE 90.1 1999 for axial fan cooling towers
p10	Cooling tower capacity control	Two-speed fan (1)	Fixed	
p11	Boiler type	Gas fired-hotwater boiler (1)	User Defined	User can choose from gas fired or electric boilers
p12	Number of boilers	1	Fixed	
p13	Boiler size (MBtu/h)	-999	Fixed	Boiler is being autosized by DOE-2
p14	Boiler fuel type	Gas (G)	Fixed	Depends on the value of p10
p15	Boilers efficiency (Et,Ec,AFUE) (%)	80	User Defined	
p16	Switch for a boiler sizing	Autosized (A)	Fixed	Boiler is being autosized by DOE-2
p17			Void	
p18	DHW heater type	Gas water heater (1)	User Defined	User can choose from gas fired or electric water heaters
p19	Number of DHW heater	1	Fixed	
p20	DHW size (MBtu/h)	-999	Fixed	Water heater is being autosized by DOE-2
p21	DHW fuel type	Gas (G)	Fixed	Depends on the value of p18
p22	DHW heater Efficiency (Et,Ec,Energy factor) (%)	54	User Defined	
p23	Switch for a DHW heater sizing	Autosized (A)	Fixed	Water heater is being autosized by DOE-2
p24	DHW Storage Capacity (gal)	75	Fixed	



	ASHRAE 90.1-1989	ASHRAE 90.1-1999
DOMHOT WATER	71.5	71.5
VENT FANS	239.2	177.9
PUMPS & MISC	184.1	111.2
HEAT REJECT	233.9	174.3
SPACE COOL	798.1	774.3
SPACE HEAT	272.1	214.3
MISC EQUIPMT	616.2	616.2
AREA LIGHTS	1289.9	1068.1

AREA LIGHTS   MISC EQUIPMT   SPACE HEAT   SPACE COOL   HEAT REJECT
PUMPS & MISC   VENT FANS   DOMHOT WATER

Figure 85: Comparison of Annual Energy Use ASHRAE Standard 90.1-1989 vs 90.1-1999

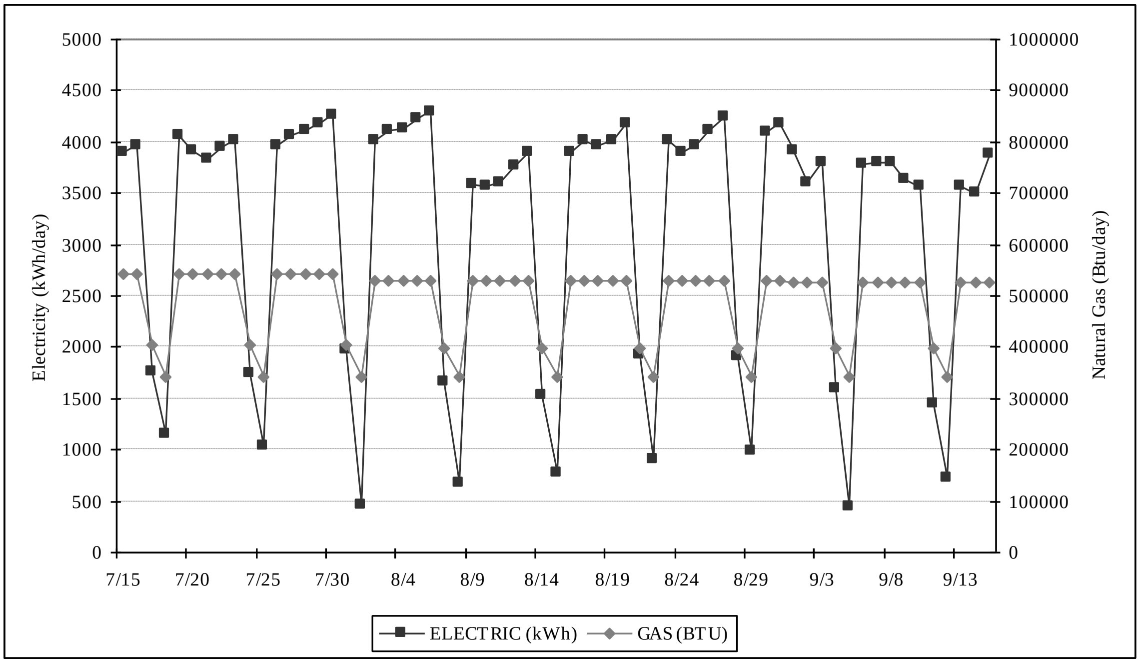


Figure 86: Simulated Electricity and Natural Gas for Building Built to 90.1-1989 Standard for OSD (07/15 – 09/15)

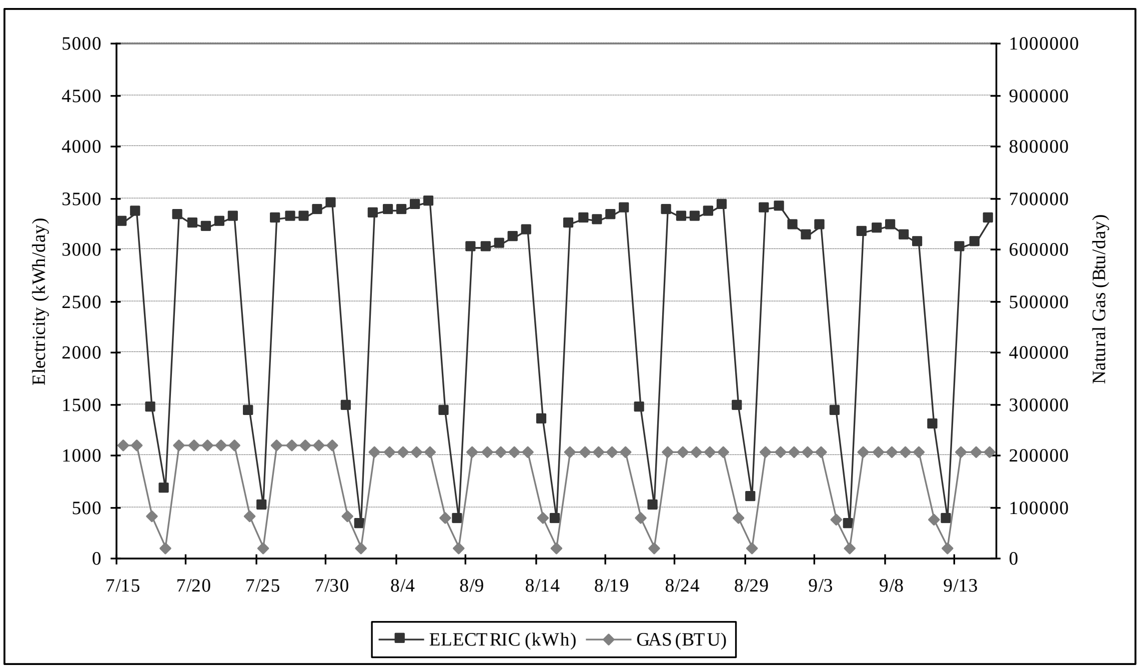


Figure 87: Simulated Electricity and Natural Gas for Building Built to 90.1-1989 Standard for OSD (07/15 – 09/15)

Table 48: Simulated Electricity and Natural Gas for Building Built to 90.1-1989 Standard for Annual and OSD (07/15 – 09/15)

	Electricity (kW)		Gas (Btu)	
	1989	1999	1989	1999
TOTAL (YEAR) (a)	988,405	858,198	331,600,000	278,800,000
OSD (07/15 - 09/15)	199,537	163,841	30,633,205	10,332,355
OSD PER DAY (b)	3167	2601	486241	164006
OSD % (b/a)	0.32%	0.30%	0.15%	0.06%

Table 49: Totalized Annual Electricity Savings from 90.1-1999 by PCA for Commercial Buildings

PCA	Total Electricity Savings by PCA (MWh)
American Electric Power - West (ERCOT)/PCA	4,773.76
Austin Energy/PCA	183.04
Brownsville Public Utils Board/PCA	0.00
Lower Colorado River Authority/PCA	916.80
Reliant Energy HL&P/PCA	10,382.09
San Antonio Public Service Bd /PCA	7,168.26
South Texas Electric Coop Inc/PCA	0.00
Texas Municipal Power Pool/PCA	0.00
Texas-New Mexico Power Co/PCA	451.99
TXU Electric/PCA	31,083.51
El Paso Electric Co/PCA	43.49
Entergy Electric System/PCA	3,060.77
Total	58,063.71

Table 50: 2009 Annual NOx Reductions from IECC / IRC by PCA for Commercial Buildings by County using 2007 eGRID

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs/year)	Lower Colorado River Auhotrity /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/PC A	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.00883113	42.157686	0.010890729	1.99341709	0.006522185	0	0.003944232	3.616055598	0.0654443	679.4488362	0.014877434	106.6453347	0.006262315	0	0.0048171	0	0.121274957	54.81451495	0.00816387	253.7617704	1142.437615	0.571218807
	Chambers	0.02176222	103.887577	0.026955801	4.933935492	0.016072371	0	0.009076193	8.32101662	0.1649402	1712.425045	0.037472294	268.6111989	0.015055623	0	0.0095532	0	0.011518588	5.20623418	0.01581859	491.697435	2595.082442	1.297541221
	Fort Bend	0.07043123	336.221647	0.087239726	15.96818378	0.052016606	0	0.029374182	26.93012968	0.5338124	5542.090663	0.12127529	869.3330092	0.048726002	0	0.030918	0	0.037278747	16.84945098	0.05119528	1591.329076	8398.72216	4.19936108
	Galveston	0.03385674	161.623871	0.041710519	7.634609305	0.025004711	0	0.015351589	14.07427363	0.2495874	2591.239814	0.056747051	406.7776961	0.024143087	0	0.0192972	0	0.567751219	256.6152862	0.03283689	1020.685823	4458.651372	2.229325686
	Harris	0.06826733	325.891706	0.084559408	15.47758363	0.050418468	0	0.028471701	26.10273905	0.5174117	5371.817667	0.117549281	842.6239665	0.047228963	0	0.0299681	0	0.03613341	16.33177512	0.04962237	1542.437712	8140.68315	4.070341575
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.00203914	9.73433719	0.003716345	0.680232237	0.001505992	0	0.005950953	5.455809054	0.0024815	25.76294165	0.000717051	5.140007103	0.019166247	0	0.0766809	0	0.00086441	0.390700803	0.0040002	124.3402508	171.5042789	0.085752139
	Dallas	0.00453947	21.6703355	0.004683963	0.857343082	0.003352602	0	0.00774211	7.09793468	0.0020856	21.65301308	0.00068106	4.882018436	0.007502816	0	0.026717	0	0.007524933	3.401160209	0.04037045	1254.855565	1314.41737	0.657208685
	Denton	0.00047388	2.26218971	0.000872802	0.159755832	0.000349982	0	0.001396994	1.280758231	0.0005854	6.078128426	0.000168971	1.211224819	0.00454374	0	0.0181872	0	0.000186605	0.084342967	0.00084941	26.40250408	37.47890406	0.018739452
	Tarrant	0.01216249	58.0607918	0.012266309	2.245200562	0.008982543	0	0.020308652	18.61888911	0.0053165	55.19645345	0.001752506	12.56242163	0.017326428	0	0.0602168	0	0.020603444	9.31245693	0.11064724	3439.304924	3595.301138	1.797650569
	Ellis	0.00327981	15.6570352	0.003307809	0.605454786	0.002422289	0	0.005476558	5.020885754	0.0014337	14.88461987	0.000472592	3.387660964	0.004672353	0	0.0162384	0	0.005556053	2.511255213	0.02983782	927.4644153	969.5313271	0.484765664
	Johnson	0.00028606	1.36557388	0.000526868	0.096436824	0.000211267	0	0.000843297	0.77313144	0.0003534	3.669070455	0.000101999	0.731157502	0.002742835	0	0.0109787	0	0.000112645	0.050913746	0.00051274	15.93790734	22.62419119	0.011312096
	Kaufman	0.00632545	30.1961779	0.006379446	1.167680865	0.004671629	0	0.010562096	9.683286608	0.002765	28.70649669	0.000911441	6.533447215	0.009011105	0	0.0313175	0	0.010715411	4.843209977	0.05754527	1788.709043	1869.839342	0.934919671
	Parker	0.00021749	1.03824209	0.000400576	0.073320654	0.000160626	0	0.000641157	0.587809723	0.0002687	2.789584248	7.75498E-05	0.555897052	0.00208537	0	0.0083471	0	8.56434E-05	0.038709582	0.00038984	12.11754743	17.20111078	0.008600555
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.00081989	3.91397977	0.000826893	0.151352906	0.000605529	0	0.001369042	1.255131958	0.0003584	3.720889699	0.00011814	0.846854867	0.001168005	0	0.0040593	0	0.001388914	0.627769048	0.00745892	231.8495748	242.3655531	0.121182777
	Hood	0.01252711	59.8013879	0.012634039	2.312509104	0.009251829	0	0.020917482	19.17706208	0.0054759	56.85117992	0.001805044	12.93902865	0.017845854	0	0.062022	0	0.021221112	9.591633724	0.11396431	3542.411348	3703.084149	1.851542075
	Hunt	0.00618756	29.5379046	0.006240374	1.142225553	0.004569788	0	0.010331844	9.472192043	0.0027047	28.08069827	0.000891572	6.391018796	0.008814664	0	0.0306347	0	0.010481817	4.737628541	0.05629078	1749.715386	1829.077054	0.914538527
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.03341375	159.509153	0.051775843	9.476946068	0.024677545	0	0.090663423	83.1198552	0.0011418	11.85470411	1.143571754	8197.421227	0.046873844	0	0.0046695	0	0.000519582	0.234843648	0.00250387	77.82892789	8539.445657	4.269722828
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.00200047	9.54974564	0.076378745	13.98021155	0.001477434	0	0.133848731	122.711968	0.0012371	12.8440296	0.003554796	25.48170878	0.001061766	0	0.0018557	0	0.000401718	0.181570837	0.00183516	57.04337096	241.7926054	0.120896303
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.00450233	21.4930509	0.171901148	31.4644399	0.003325174	0	0.301245466	276.1806093	0.0027843	28.90730202	0.008000571	57.35018328	0.002389654	0	0.0041765	0	0.000904124	0.408650803	0.0041303	128.3841601	544.1883963	0.272094198
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.0024586	11.7367567	0.093870431	17.18185467	0.001815785	0	0.164501762	150.814542	0.0015205	15.78547286	0.004368889	31.31733847	0.001304924	0	0.0022807	0	0.000493717	0.223152827	0.00225544	70.10701564	297.1661331	0.148583067
	Travis	0.00051001	2.43464992	0.299602906	54.83871232	0.000376663	0	0.033939476	31.11557278	0.0003347	3.474978317	0.000906121	6.495312228	0.000271138	0	0.0004717	0	0.000103327	0.04670224	0.00046734	14.52643784	112.9323656	0.056466183
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0.00068596	3.27462997	0.00069182	0.126629362	0.000506616	0	0.001145408	1.050105765	0.0002999	3.113081217	9.88414E-05	0.708520863	0.000977211	0	0.0033962	0	0.001162035	0.52522278	0.00624051	193.9768752	202.7750651	0.101387533
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22756873	1086.35799	0.004556851	0.834076883	0.168069652	0	0.007612767	6.979353707	0.0016809	17.45113701	0.001626796	11.6612988	0.046792036	0	0.0072464	0	0.001609426	0.727437106	0.00828339	257.4770138	1381.488303	0.690744152
	San Patricio	0.05031335	240.18375	0.001007478	0.184406721	0.037158653	0	0.001683113	1.543070855	0.0003716	3.858285742	0.00035967	2.578205814	0.010345288	0	0.0016021	0	0.000355829	0.160829648	0.00183138	56.92579751	305.4343463	0.152717173
Victoria Area	Victoria	0.02183674	104.243286	0.002215582	0.405535697	0.016127403	0	0.003612695	3.312104222	0.0011996	12.45458012	0.000555389	3.981172038	0.52545648	0	0.0324127	0	0.000476855	0.215531671	0.00225485	70.08863511	194.7008448	0.097350422
Other ERCOT counties	Andrews	2.4742E-05	0.11811271	2.49533E-05	0.004567398	1.82731E-05	0	4.13138E-05	0.03787629	1.082E-05	0.112285803	3.56511E-06	0.025555656	3.5247E-05	0	0.0001225	0	4.19135E-05	0.018944273	0.00022509	6.996556651	7.31389878	0.003656949
	Angelina	0.00031082	1.483779	0.000313473	0.057377472	0.000229554	0	0.000519	0.475817083	0.0001359	1.41057908	4.47864E-05	0.321040358	0.000442787	0	0.0015389	0	0.000526534	0.237985525	0.00282766	87.89353795	91.88011646	0.045940058
	Bosque	0.00059539	2.84225608	0.001096604	0.200720117	0.000439723	0	0.001755208	1.609167809	0.0007356	7.636670502	0.000212298	1.521804772	0.005708837	0	0.0228507	0	0.000234455	0.105970029	0.00106721	33.17258372	47.08917303	0.023544587
	Brazos	0.00193973	9.25977821	0.003572622	0.653925515	0.001432574	0	0.005718288	5.242503352	0.0023964	24.8794877	0.000691644	4.957883556	0.018598805	0	0.0744451	0	0.000763829	0.345239464	0.00347685	108.0728687	153.4116865	0.076705843
	Calhoun	0.08269981	394.788852	0.001655986	0.303108422	0.061077496	0	0.002766524	2.536337994	0.0006108	6.341845346	0.000591187	4.237784247	0.0170045	0	0.0026334	0	0.000584875	0.264354903	0.00301023	93.56865409	502.0409366	0.251020468
	Cameron	0.04837175	230.915001	0.000968599	0.177290421	0.297964476	0	0.001618161	1.48352338	0.0003573	3.709393569	0.00034579	2.478712232	0.009946061	0	0.0015403	0	0.000342098	0.154623193	0.00176071	54.72901732	293.6475616	0.146823781
	Cherokee	0.0035039	16.7267645	0.003533808	0.646821028	0.002587786	0	0.00585073	5.363925695	0.0015316	15.90157572	0.00050488	3.61911475	0.00499158	0	0.0173479	0	0.005935657	2.682830685	0.03187642	990.8311904	1035.772223	0.517886111
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.00129879	6.20009392	2.6007E-05	0.004760268	0.000959212	0	4.34478E-05	0.039832771	9.593E-06	0.099597637	9.2845E-06	0.066553704	0.000267053	0	4.136E-05	0	9.18536E-06	0.00415165	4.7275E-05	1.469480308	7.884470256	0.003942235
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.00353575	16.8788026	0.003565928	0.652700316	0.002611307	0	0.005903911	5.412681167	0.0015456	16.0461133	0.00050947	3.65201074	0.005036951	0	0.0175056	0	0.00598961	2.707216309	0.03216616	999.8373633	1045.186888	0.522593444
	Fannin	0.00705631	33.6851369	0.007116546	1.302598293	0.005211403	0	0.011782473	10.80212324	0.0030845	32.02333335	0.001016752	7.288341741	0.010052276	0	0.034936	0	0.011953503	5.402809309	0.06419422	1995.381971	2085.886314	1.042943157
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.00367718	17.5539547	0.003708565	0.678808328	0.00271576	0	0.006140067	5.629188414	0.0016074	16.68795783	0.000529848	3.79809117	0.005238429	0	0.0182058	0	0.006229194	2.815504961	0.03345281	1039.830858	1086.994363	0.543497182
	Frio	0.00858833	40.998629	0.000871383	0.159496196	0.006342868	0	0.001420864	1.302642478	0.0004718	4.898355856	0.000218433	1.565785211	0.206660746	0	0.0127478	0	0.000187546	0.084768078	0.00088683	27.56568851	76.57536536	0.038287683
	Grimes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.18852746	899.984402	0.003775086	0.690984182	0.139235931	0	0.006306735	5.781988581	0.0013925	14.45725194	0.001347706	9.660707756	0.03876448	0	0.0060032	0	0.001333316	0.60263933	0.00686231	213.3047294	1144.482703	0.572241351
	Howard	0.00055511	2.64997521	0.000559851	0.102474073	0.000409976	0	0.000926915	0.849791967	0.0002427	2.519242822	7.99868E-05	0.573366377	0.000790802	0	0.0027484	0	0.00094037	0.425033472	0.00505009	156.9746551	164.094539	0.08204727
	Jack	0.00212145	10.1272816	0.002139557	0.391620189	0.001566784	0	0.003542346	3.2476087	0.0009273	9.627667979	0.000305682	2.191206444	0.00302217	0	0.0105033	0	0.003593766	1.624329785	0.0192997	599.902418	627.1121327	0.313556066
	Jones	0.04071872	194.381315	0.000815354	0.149240824	0.030072592	0	0.001362147	1.248811138	0.0003008	3.12252039	0.000291082	2.086548472	0.008372468	0	0.0012966	0	0.000287974	0.13015984	0.00148214	46.07019161	247.1887874	0.123594394
	Lamar	0.00095084	4.53906952	0.000958954	0.175525016	0.000702236	0	0.001587687	1.455585248	0.0004156	4.315141624	0.000137007	0.98210347	0.001354543	0	0.0047076	0	0.001610734	0.728028125	0.00865017	268.877562	281.073015	0.140536508
	Limestone	0.00071976	3.43594451	0.000891528	0.163183406	0.000531572	0	0.000300183	0.275206645	0.0054552	56.63619872	0.001239347	8.883960954	0.000497945	0	0.000316	0	0.000380962	0.172189326	0.00052318	16.26224384	85.8289274	0.042914464
	Llano	0.00123817	5.91074249	0.047274044	8.652945702	0.000914447	0	0.082844655	75.95164013	0.0007657	7.94971452	0.002200214	15.77171001	0.000657172	0	0.0011486	0	0.000248641	0.11238189	0.00113586	35.30656098	149.6556957	0.074827848
	McLennan	0.02453432	117.120887	0.024743738	4.529044002	0.018119687	0	0.040966843	37.55823397	0.0107245	111.342911	0.003535175	25.34105919	0.034951066	0	0.1214699	0	0.041561501	18.78519358	0.22319886	6937.804845	7252.482173	3.626241087
	Milam	0.0022454	10.7190191	0.002264571	0.414502574	0.001658332	0	0.003749326	3.43736662	0.0009815	10.19021304	0.000323543	2.319238733	0.003198756	0	0.011117	0	0.00380375	1.719239446	0.02042738	634.9547427	663.7543222	0.331877161
	Mitchell	0.01494317	71.3350674	0.015070721	2.758514451	0.011036196	0	0.024951762	22.87567335	0.006532	67.81586333	0.002153177	15.43453275	0.02128772	0	0.073984	0	0.025313952	11.44153776	0.1359442	4225.623534	4417.284723	2.208642362
	Nolan	0.00056465	2.69551999	0.000569473	0.104235282	0.000417022	0	0.000942846	0.864397231	0.0002468	2.562540721	8.13615E-05	0.58322075	0.000804394	0	0.0027956	0	0.000956532	0.432338467	0.00513689	159.6725581	166.9148105	0.083457405
	Palo Pinto	0.003207	15.3094332	0.005906709	1.081152134	0.002368511	0	0.009454195	8.667567717	0.003962	41.13390681	0.001143513	8.196998374	0.030749889	0	0.1230821	0	0.001262858	0.570793423	0.00574838	178.6796965	253.6395481	0.126819774
	Pecos	4.0968E-05	0.19556977	4.13174E-05	0.007562649	3.02565E-05	0	6.84069E-05	0.062715162	1.791E-05	0.185921645	5.90308E-06	0.042314786	5.83617E-05	0	0.0002028	0	6.93999E-05	0.031367728	0.0003727	11.58482456	12.11027631	0.006055138
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.00073771	3.521638	0.000835096	0.152854362	0.00054483	0	0.000735917	0.674685745	0.0031497	32.70025349	0.000730875	5.239105149	0.00076086	0	0.0018663	0	0.191632518	86.61510858	0.00339774	105.6136175	234.5172628	0.117258631
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0.00569644	27.193412	0.005745061	1.051564437	0.004207073	0	0.009511781	8.72036199	0.00249	25.85186753	0.000820806	5.883748676	0.008115023	0	0.0282032	0	0.00964985	4.361591875	0.05182285	1610.83638	1683.898927	0.841949463
	Tom Green	0.00148245	7.07684786	2.96846E-05	0.005433416	0.001094854	0	4.95918E-05	0.045465514	1.095E-05	0.113681717	1.05974E-05	0.075965049	0.000304817	0	4.72E-05	0	1.04843E-05	0.004738734	5.396E-05	1.677279201	8.999411492	0.004499706
	Upton	3.1166E-05	0.14877954	3.14322E-05	0.005753279	2.30176E-05	0	5.20405E-05	0.047710506	1.362E-05	0.141439734	4.49076E-06	0.032190937	4.43986E-05	0	0.0001543	0	5.27959E-05	0.023862972	0.00028353	8.813145439	9.212882406	0.004606441
	Ward	0.01855953	88.5986933	0.01871795	3.426095817	0.013707039	0	0.030990277	28.41175936	0.0081128	84.22781532	0.002674262	19.16980645	0.026439509	0	0.0918886	0	0.03144012	14.21047646	0.16884373	5248.256398	5486.301045	2.743150522
	Webb	0.02001433	95.5435495	0.000400768	0.073355806	0.014781473	0	0.000669531	0.613823652	0.0001478	1.53480123	0.000143074	1.025593675	0.004115289	0	0.0006373	0	0.000141547	0.063976998	0.00072851	22.64471578	121.498167	0.060749908
	Wharton	0.00014434	0.68904275	0.000178787	0.032724726	0.000106601	0	6.01986E-05	0.055189815	0.001094	11.35779747	0.000248538	1.78158548	9.98576E-05	0	6.336E-05	0	7.6398E-05	0.034530769	0.00010492	3.261222967	17.21209398	0.008606047
	Wichita	0.00020763	0.99119064	0.000209406	0.038329167	0.000153346	0	0.000346701	0.317854237	9.076E-05	0.942291802	2.99181E-05	0.214460643	0.00029579	0	0.001028	0	0.000351734	0.158978544	0.00188893	58.71443966	61.3775447	0.030688772
	Wilbarger	0.02861682	136.609757	0.000573025	0.104885352	0.021134796	0	0.000957307	0.877655271	0.0002114	2.194484335	0.00020457	1.466410901	0.005884109	0	0.0009112	0	0.000202386	0.091475377	0.00104164	32.37779139	173.7224595	0.08686123
	Wise	0.00284449	13.5788945	0.002882008	0.527516945	0.002100781	0	0.00476997	4.373089396	0.0012561	13.04069332	0.000413241	2.962221564	0.004181914	0	0.0146143	0	0.004797945	2.168601109	0.02576141	800.7551798	837.4061966	0.418703098
	Young	0.00623586	29.7684674	0.006289085	1.151141373	0.004605458	0	0.010412491	9.546128724	0.0027258	28.29988657	0.000898531	6.440904896	0.008883468	0	0.0308739	0	0.010563634	4.774608843	0.05673017	1763.373064	1843.354202	0.921677101
	Total	**1.12183722**	**5355.37911**	**1.172570094**	**214.6248678**	**1.090766584**	**0**	**1.189130767**	**1090.190217**	**1.62936**	**16916.16997**	**1.542362643**	**11056.05855**	**1.359385821**	**0**	**1.2316428**	**0**	**1.221806085**	**552.2385645**	**1.52878695**	**47520.07008**	**82704.73136**	**41.35236568**

Energy Savings by PCA (MWh)																				
		4,773.76		183.04		0.00		916.80		10,382.09		7,168.26		0.00		0.00		451.99		31,083.51

Table 51: 2008 Totalized OSD Electricity Savings from IECC/IRC by PCA for Commercial Buildings (w/7% T&D)

PCA	Total Electricity Savings by PCA (MWh)
American Electric Power - West (ERCOT)/PCA	29.06
Austin Energy/PCA	1.03
Brownsville Public Utils Board/PCA	0.00
Lower Colorado River Authority/PCA	4.92
Reliant Energy HL&P/PCA	74.08
San Antonio Public Service Bd /PCA	42.14
South Texas Electric Coop Inc/PCA	0.00
Texas Municipal Power Pool/PCA	0.00
Texas-New Mexico Power Co/PCA	2.47
TXU Electric/PCA	197.47
El Paso Electric Co/PCA	0.22
Entergy Electric System/PCA	23.16
Total	374.56

Table 52: 2009 OSD NOx Reductions from Electricity Savings from the IECC/IRC by PCA for Commercial Buildings by County using 2007 eGRID (w/7% T&D)

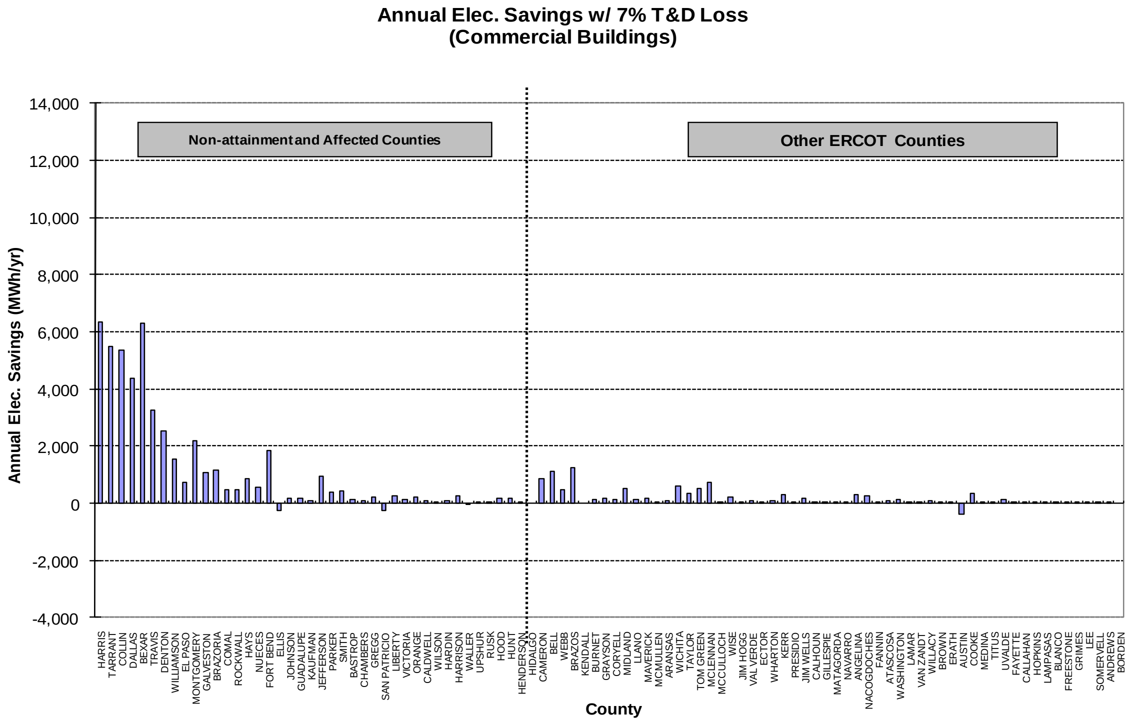
Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs/year)	Lower Colorado River Auhotrity /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/PCA	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.00957217	0.27816581	0.011806715	0.012157533	0.007069474	0	0.004263638	0.020992488	0.0710018	5.259801803	0.016140391	0.680229075	0.006781035	0	0.0051797	0	0.126288	0.311448413	0.008772	1.732173298	8.294968416	0.004147484
	Chambers	0.0218814	0.63587006	0.027103415	0.027908751	0.016160386	0	0.009125896	0.044932349	0.1658435	12.28566246	0.037677498	1.587900212	0.01513807	0	0.0096055	0	0.011582	0.028562413	0.015905	3.140864708	17.75170095	0.00887585
	Fort Bend	0.05569551	1.61850321	0.068987309	0.071037161	0.041133619	0	0.023228475	0.114367944	0.4221274	31.27114391	0.095901908	4.041740216	0.038531479	0	0.0244493	0	0.029479	0.072700949	0.040484	7.994557283	45.18405067	0.022592025
	Galveston	0.02755599	0.80077278	0.033893644	0.034900741	0.020351324	0	0.012791501	0.062980361	0.2014466	14.92314082	0.045812515	1.930746628	0.019823685	0	0.0167751	0	0.594657	1.466526936	0.028709	5.66936644	24.88843471	0.012444217
	Harris	0.07736057	2.2480866	0.09582276	0.098669986	0.057134232	0	0.032264145	0.158856061	0.5863312	43.43534163	0.1332069	5.613941324	0.053519883	0	0.0339599	0	0.040946	0.100980974	0.056232	11.10436918	62.76024576	0.031380123
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.00176365	0.05125137	0.003151138	0.003244769	0.001302533	0	0.005050143	0.024864932	0.0020858	0.154512186	0.00060408	0.025458663	0.015958397	0	0.0637888	0	0.000846	0.002086719	0.004013	0.792503593	1.053922234	0.000526961
	Dallas	0.00504555	0.14662301	0.005305276	0.005462914	0.003726366	0	0.008757286	0.043117461	0.0024131	0.178761156	0.000782263	0.032968113	0.009310387	0	0.033672	0	0.008209	0.020245272	0.044002	8.689281071	9.116458995	0.004558229
	Denton	0.00063576	0.01847503	0.001170951	0.001205744	0.000469535	0	0.001874207	0.009227864	0.0007854	0.058184615	0.000226691	0.009553778	0.006095882	0	0.0243999	0	0.00025	0.000617407	0.00114	0.225033768	0.322298201	0.000161149
	Tarrant	0.01557224	0.45252704	0.015705165	0.01617182	0.011500796	0	0.026002176	0.12802457	0.006807	0.504260566	0.002243821	0.094564751	0.022183886	0	0.0770985	0	0.02638	0.06505674	0.141667	27.9755603	29.23616579	0.014618083
	Ellis	0.00350282	0.10179153	0.003532723	0.003637693	0.002586991	0	0.005848935	0.028797873	0.0015312	0.113428476	0.000504725	0.021271415	0.004990048	0	0.0173426	0	0.005934	0.014633877	0.031867	6.292828323	6.576389183	0.003288195
	Johnson	0.00033718	0.00979828	0.000621017	0.00063947	0.00024902	0	0.000993991	0.004894025	0.0004166	0.030858382	0.000120226	0.005066874	0.003232969	0	0.0129406	0	0.000133	0.000327443	0.000604	0.119347322	0.170931801	8.54659E-05
	Kaufman	0.00649275	0.18867841	0.006548174	0.006742743	0.004795187	0	0.01084145	0.053379069	0.0028381	0.21024839	0.000935547	0.0394282	0.009249437	0	0.0321458	0	0.010999	0.027125014	0.059067	11.66424047	12.1898423	0.006094921
	Parker	0.00047595	0.01383108	0.000876616	0.000902664	0.000351511	0	0.0014031	0.006908317	0.000588	0.043559135	0.000169709	0.007152308	0.0045636	0	0.0182667	0	0.000187	0.000462213	0.000853	0.168468525	0.241284244	0.000120642
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.00095027	0.02761473	0.000958382	0.000986859	0.000701818	0	0.001586741	0.007812493	0.0004154	0.030771688	0.000136926	0.005770662	0.001353736	0	0.0047048	0	0.00161	0.003969983	0.008645	1.707163485	1.784089904	0.000892045
	Hood	0.01232788	0.35824639	0.012433111	0.012802542	0.00910469	0	0.020584816	0.101351602	0.0053888	0.399201621	0.001776337	0.074862887	0.017562038	0	0.0610356	0	0.020884	0.051502651	0.112152	22.14706	23.14502769	0.011572514
	Hunt	0.00635121	0.18456524	0.006405424	0.006595752	0.004690653	0	0.010605108	0.052215412	0.0027763	0.205664998	0.000915153	0.03856867	0.0090478	0	0.031445	0	0.010759	0.026533692	0.05778	11.40996133	11.9241051	0.005962053
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.03112811	0.9045783	0.048234164	0.049667368	0.0229895	0	0.084461674	0.415856326	0.0010637	0.078801326	1.065346769	44.89853197	0.043667482	0	0.0043501	0	0.000484	0.001193729	0.002333	0.460625665	46.80925468	0.023404627
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.00200761	0.05834086	0.076651484	0.078929065	0.00148271	0	0.134326688	0.661372196	0.0012416	0.091973896	0.00356749	0.150350167	0.001065557	0	0.0018623	0	0.000403	0.000994245	0.001842	0.363691159	1.40565159	0.000702826
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.00446951	0.12988342	0.170648096	0.175718642	0.003300936	0	0.299049574	1.472403407	0.002764	0.204760161	0.007942252	0.334722414	0.002372235	0	0.0041461	0	0.000898	0.002213474	0.0041	0.809680397	3.129381915	0.001564691
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.00246935	0.07175902	0.094281013	0.097082428	0.001823727	0	0.165221279	0.813485108	0.0015271	0.113127517	0.004387998	0.184930093	0.001310631	0	0.0022907	0	0.000496	0.001222918	0.002265	0.447338645	1.728945731	0.000864473
	Travis	0.00050761	0.01475105	0.298194277	0.307054662	0.000374892	0	0.033779905	0.166319069	0.0003331	0.024678605	0.000901861	0.038008491	0.000269863	0	0.0004695	0	0.000103	0.000253624	0.000465	0.0918527	0.642918196	0.000321459
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22352453	6.49558905	0.00447587	0.004608863	0.165082827	0	0.007477478	0.036816183	0.001651	0.122307068	0.001597886	0.067342128	0.045960479	0	0.0071176	0	0.001581	0.003898589	0.008136	1.606684378	8.337246261	0.004168623
	San Patricio	0.05533089	1.60790722	0.001107949	0.00114087	0.040864326	0	0.001850962	0.009113416	0.0004087	0.030275687	0.000395538	0.016669757	0.01137698	0	0.0017619	0	0.000391	0.00096505	0.002014	0.397715956	2.063787957	0.001031894
Victoria Area	Victoria	0.02060475	0.59877099	0.002090584	0.002152702	0.015217528	0	0.003408874	0.016783968	0.0011319	0.083854042	0.000524055	0.022086044	0.495811308	0	0.0305841	0	0.00045	0.001109661	0.002128	0.420152343	1.144909752	0.000572455
Other ERCOT counties	Andrews	2.5653E-05	0.00074546	2.58716E-05	2.66404E-05	1.89456E-05	0	4.28342E-05	0.000210899	1.121E-05	0.000830685	3.69632E-06	0.00015578	3.65442E-05	0	0.000127	0	4.35E-05	0.00010717	0.000233	0.046085051	0.048161687	2.40808E-05
	Angelina	0.00032149	0.00934246	0.000324234	0.000333868	0.000237435	0	0.000536817	0.002643077	0.0001405	0.010410498	4.63239E-05	0.001952297	0.000457988	0	0.0015917	0	0.000545	0.001343101	0.002925	0.577557604	0.603582902	0.000301791
	Bosque	0.00093945	0.02730035	0.001730301	0.001781715	0.000693828	0	0.002769496	0.013635918	0.0011606	0.085978798	0.000334979	0.014117518	0.009007821	0	0.0360555	0	0.00037	0.000912335	0.001684	0.332530047	0.476256684	0.000238128
	Brazos	0.00191393	0.05561841	0.003525105	0.003629848	0.00141352	0	0.005642234	0.027780157	0.0023645	0.175162719	0.000682445	0.028761309	0.018351436	0	0.073455	0	0.000754	0.001858681	0.003431	0.677456172	0.970267297	0.000485134
	Calhoun	0.08852525	2.57253032	0.001772635	0.001825307	0.065379841	0	0.0029614	0.014580779	0.0006539	0.048438816	0.000632831	0.026670355	0.01820231	0	0.0028189	0	0.000626	0.001544008	0.003222	0.636315543	3.301905128	0.001650953
	Cameron	0.05467229	1.58876844	0.001094762	0.001127291	0.285623104	0	0.001828931	0.00900494	0.0004038	0.029915318	0.00039083	0.016471339	0.011241561	0	0.0017409	0	0.000387	0.000953563	0.00199	0.392981979	2.039222874	0.001019611
	Cherokee	0.003513	0.10208711	0.003542982	0.003648256	0.002594504	0	0.005865919	0.028881497	0.0015356	0.11375785	0.000506191	0.021333183	0.005004538	0	0.0173929	0	0.005951	0.01467637	0.031959	6.31110147	6.595485735	0.003297743
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.0013551	0.03937898	2.71346E-05	2.79409E-05	0.001000801	0	4.53316E-05	0.000223195	1.001E-05	0.000741477	9.68705E-06	0.000408256	0.000278632	0	4.315E-05	0	9.58E-06	2.36349E-05	4.93E-05	0.009740394	0.050543881	2.52719E-05
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.00362926	0.10546585	0.003660242	0.003769001	0.002680373	0	0.006060061	0.029837378	0.0015864	0.117522856	0.000522944	0.02203924	0.005170172	0	0.0179686	0	0.006148	0.015162109	0.033017	6.519977905	6.813774343	0.003406887
	Fannin	0.00762852	0.22168353	0.007693632	0.007922236	0.005633999	0	0.012737922	0.062716559	0.0033346	0.247026702	0.001099201	0.046325293	0.010867422	0	0.0377689	0	0.012923	0.031869936	0.0694	13.70464171	14.32218597	0.007161093
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.00377443	0.10968449	0.003806652	0.003919761	0.002787588	0	0.006302464	0.031030873	0.0016499	0.12222377	0.000543862	0.02292081	0.005376978	0	0.0186873	0	0.006394	0.015768594	0.034338	6.780777021	7.086325316	0.003543163
	Frio	0.01476384	0.42903492	0.001497957	0.001542467	0.010903753	0	0.002442547	0.012026147	0.0008111	0.060083591	0.000375499	0.015825222	0.355261637	0	0.0219143	0	0.000322	0.000795101	0.001525	0.30105003	0.820357475	0.000410179
	Grimes	0.00055442	0.01611148	0.001021149	0.001051491	0.000409467	0	0.001634436	0.008047327	0.0006849	0.050740957	0.00019769	0.008331547	0.005316025	0	0.0212784	0	0.000218	0.000538421	0.000994	0.196244809	0.281066035	0.000140533
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.239737	6.96672099	0.004800509	0.004943149	0.177056459	0	0.008019827	0.0394865	0.0017708	0.131178129	0.001713782	0.072226524	0.049294041	0	0.0076338	0	0.001695	0.004181358	0.008726	1.723218895	8.941955549	0.004470978
	Howard	0.00058508	0.01700236	0.000590075	0.000607608	0.000432108	0	0.000976955	0.004810144	0.0002558	0.018946096	8.43049E-05	0.00355299	0.000833494	0	0.0028967	0	0.000991	0.002444314	0.005323	1.051098725	1.098462239	0.000549231
	Jack	0.00217756	0.06327951	0.002196145	0.002261401	0.001608224	0	0.003636037	0.017902427	0.0009519	0.070513714	0.000313767	0.013223544	0.003102103	0	0.0107811	0	0.003689	0.009097266	0.01981	3.911986743	4.088264606	0.002044132
	Jones	0.04250012	1.2350472	0.000851025	0.000876312	0.031388236	0	0.00142174	0.007000092	0.0003139	0.023255012	0.000303816	0.012804182	0.008738755	0	0.0013533	0	0.000301	0.000741263	0.001547	0.305489005	1.585213062	0.000792607
	Lamar	0.00107998	0.03138407	0.001089199	0.001121563	0.000797614	0	0.001803327	0.008878877	0.0004721	0.03497194	0.000155616	0.006558341	0.001538517	0	0.005347	0	0.00183	0.004511875	0.009825	1.94018666	2.027613326	0.001013807
	Limestone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Llano	0.00124346	0.03613476	0.047475864	0.048886536	0.000918351	0	0.083198331	0.409636117	0.000769	0.056966153	0.002209607	0.093122842	0.000659977	0	0.0011535	0	0.00025	0.000615809	0.001141	0.225260504	0.870622718	0.000435311
	McLennan	0.02303137	0.6692881	0.023227961	0.023918144	0.017009692	0	0.038457253	0.189348509	0.0100675	0.745802046	0.003318614	0.139861392	0.032809997	0	0.1140288	0	0.039015	0.096219005	0.209526	41.37589079	43.24032799	0.021620164
	Milam	0.00165249	0.04802117	0.001666598	0.001716118	0.001220439	0	0.002759294	0.013585685	0.0007223	0.053511019	0.000238109	0.010035003	0.002354105	0	0.0081815	0	0.002799	0.006903678	0.015033	2.96870474	3.102477414	0.001551239
	Mitchell	0.01696145	0.49289727	0.017106233	0.017614519	0.012526789	0	0.028321847	0.139445724	0.0074142	0.549245973	0.002443993	0.103000932	0.024162925	0	0.0839765	0	0.028733	0.070860493	0.154305	30.47127789	31.8443428	0.015922171
	Nolan	0.00060327	0.01753102	0.000608422	0.000626501	0.000445544	0	0.001007331	0.004959706	0.0002637	0.01953519	8.69262E-05	0.003663464	0.00085941	0	0.0029868	0	0.001022	0.002520316	0.005488	1.083780729	1.132616924	0.000566308
	Palo Pinto	0.00307488	0.08935553	0.00566337	0.005831648	0.002270935	0	0.00906471	0.044631095	0.0037988	0.281413244	0.001096403	0.046207397	0.029483083	0	0.1180115	0	0.001211	0.002986123	0.005512	1.088388783	1.558813821	0.000779407
	Pecos	4.2262E-05	0.00122812	4.26225E-05	4.3889E-05	3.12122E-05	0	7.05678E-05	0.000347448	1.847E-05	0.001368522	6.08954E-06	0.000256641	6.02052E-05	0	0.0002092	0	7.16E-05	0.000176559	0.000384	0.075923359	0.079344538	3.96723E-05
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.00035926	0.01043997	0.000406685	0.000418769	0.000265328	0	0.000358385	0.00176455	0.0015339	0.113628648	0.00035593	0.015000506	0.000370532	0	0.0009089	0	0.093323	0.230151898	0.001655	0.326754003	0.698158342	0.000349079
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tom Green	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upton	3.2238E-05	0.00093683	3.25131E-05	3.34792E-05	2.38092E-05	0	5.38302E-05	0.000265039	1.409E-05	0.00104393	4.6452E-06	0.00019577	4.59255E-05	0	0.0001596	0	5.46E-05	0.000134682	0.000293	0.05791553	0.060525259	3.02626E-05
	Ward	0.01980763	0.57560662	0.0199767	0.020570277	0.014628815	0	0.033074321	0.162845052	0.0086584	0.64141077	0.002854101	0.120284737	0.028217522	0	0.098068	0	0.033554	0.082751055	0.180198	35.58443168	37.18790019	0.01859395
	Webb	0.01418005	0.41206999	0.000283942	0.000292379	0.010472596	0	0.000474359	0.002335561	0.0001047	0.007758969	0.000101367	0.004272079	0.002915661	0	0.0004515	0	0.0001	0.00024732	0.000516	0.101925539	0.528901838	0.000264451
	Wharton	0.00015439	0.00448655	0.000191235	0.000196918	0.000114024	0	6.43902E-05	0.000317032	0.0011702	0.086684748	0.000265844	0.011203851	0.000106811	0	6.777E-05	0	8.17E-05	0.00020153	0.000112	0.022161203	0.125251831	6.26259E-05
	Wichita	0.00021984	0.0063886	0.000221719	0.000228308	0.000162364	0	0.000367089	0.001807402	9.61E-05	0.007118957	3.16774E-05	0.001335029	0.000313184	0	0.0010884	0	0.000372	0.000918446	0.002	0.394948206	0.41274495	0.000206372
	Wilbarger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Wise	0.00291847	0.08481033	0.002955932	0.003043763	0.002155421	0	0.004892446	0.024088495	0.0012878	0.095396583	0.000423725	0.017857705	0.004280539	0	0.0149528	0	0.004924	0.012144313	0.026441	5.221313004	5.458654189	0.002729327
	Young	0.00549666	0.15973212	0.005543579	0.005708298	0.004059529	0	0.009178198	0.045189864	0.0024027	0.177992915	0.000792019	0.033379282	0.007830425	0	0.0272141	0	0.009311	0.022963602	0.050005	9.874758944	10.31972502	0.005159863
	Total	1.14303735	33.2164934	1.154658244	1.188967139	1.089429227	0	1.180868675	5.814136562	1.5393506	114.0348967	1.443965054	60.85521919	1.48172714	0	1.2697054	0	1.151969	2.840955914	1.517783	299.722395	517.673064	0.258836532
Energy Savings by PCA (MWh)		29.06		1.03		0.00		4.92		74.08		42.14		0.00		0.00		2.47		197.47			

Table 53: 2009 Annual and OSD NOx Reductions from IECC/IRC by PCA for Commercial Buildings by County using 2007 eGRID (w/7% T&D) (1)

	Electricity Savings and Resultant NOx Reductions (Office)				Total Natural Gas Savings and Resultant NOx Reductions (Office)				Total Nox Reductions	
County	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Total OSD N.G. Savings (Therm/County)	OSD Nox Reductions (Tons)	Annual Nox Reductions (Tons)	OSD Nox Reductions (Tons)
HARRIS	6,364.77	4.07	56.08	0.03	(126,152.41)	(0.58)	2,040.2133	0.0094	3.49	0.0408
TARRANT	5,479.22	1.80	37.25	0.01	(59,566.62)	(0.27)	1,084.5248	0.0050	1.52	0.0196
COLLIN	5,364.78	0.09	29.46	0.00	(34,863.73)	(0.16)	617.2667	0.0028	(0.07)	0.0034
DALLAS	4,373.06	0.66	36.35	0.00	(82,112.16)	(0.38)	1,234.0985	0.0057	0.28	0.0102
BEXAR	6,304.29	4.27	36.95	0.02	(39,419.45)	(0.18)	957.9633	0.0044	4.09	0.0278
TRAVIS	3,273.24	0.06	18.98	0.00	(15,976.54)	(0.07)	447.8557	0.0021	(0.02)	0.0024
DENTON	2,548.74	0.02	16.60	0.00	(29,244.88)	(0.13)	506.8846	0.0023	(0.12)	0.0025
WILLIAMSON	1,549.60	0.00	8.35	0.00	(10,646.90)	(0.05)	183.4041	0.0008	(0.05)	0.0008
EL PASO	730.98	0.00	9.20	0.00	(27,871.28)	(0.13)	428.3613	0.0020	(0.13)	0.0020
MONTGOMERY	2,179.97	0.00	11.97	0.00	(14,838.59)	(0.07)	257.5907	0.0012	(0.07)	0.0012
GALVESTON	1,067.06	2.23	5.70	0.01	(6,018.20)	(0.03)	115.5423	0.0005	2.20	0.0130
BRAZORIA	1,149.37	0.57	6.26	0.00	(9,686.20)	(0.04)	146.3996	0.0007	0.53	0.0048
COMAL	465.37	0.00	2.48	0.00	(2,922.68)	(0.01)	55.6054	0.0003	(0.01)	0.0003
ROCKWALL	470.71	0.00	2.50	0.00	(3,850.90)	(0.02)	55.0408	0.0003	(0.02)	0.0003
HAYS	843.73	0.15	4.53	0.00	(6,128.38)	(0.03)	99.6230	0.0005	0.12	0.0013
NUECES	563.49	0.69	3.60	0.00	(3,802.42)	(0.02)	111.9558	0.0005	0.67	0.0047
FORT BEND	1,842.29	4.20	11.59	0.02	(20,053.04)	(0.09)	306.0918	0.0014	4.11	0.0240
ELLIS	(242.80)	0.48	0.23	0.00	(5,790.88)	(0.03)	70.3569	0.0003	0.46	0.0036
JOHNSON	191.18	0.01	1.23	0.00	(3,065.49)	(0.01)	39.1093	0.0002	(0.00)	0.0003
GUADALUPE	199.95	0.12	1.69	0.00	(4,173.12)	(0.02)	60.9884	0.0003	0.10	0.0010
KAUFMAN	105.93	0.93	0.88	0.01	(2,978.21)	(0.01)	38.3237	0.0002	0.92	0.0063
JEFFERSON	945.30	0.00	5.26	0.00	(1,832.05)	(0.01)	122.7066	0.0006	(0.01)	0.0006
PARKER	391.05	0.01	2.00	0.00	(2,089.06)	(0.01)	42.7254	0.0002	(0.00)	0.0003
SMITH	446.30	0.00	3.07	0.00	(4,091.05)	(0.02)	94.8573	0.0004	(0.02)	0.0004
BASTROP	140.26	0.27	0.78	0.00	(258.29)	(0.00)	22.2030	0.0001	0.27	0.0017
CHAMBERS	89.87	1.30	0.44	0.01	(707.16)	(0.00)	9.3559	0.0000	1.29	0.0089
GREGG	237.31	0.00	1.50	0.00	(983.54)	(0.00)	45.6052	0.0002	(0.00)	0.0002
SAN PATRICIO	(269.26)	0.15	(0.18)	0.00	(3,815.23)	(0.02)	42.3554	0.0002	0.14	0.0012
LIBERTY	281.73	0.00	1.38	0.00	(2,444.75)	(0.01)	35.4456	0.0002	(0.01)	0.0002
VICTORIA	146.48	0.10	0.80	0.00	(719.04)	(0.00)	17.0053	0.0001	0.09	0.0007
ORANGE	207.00	0.00	1.10	0.00	(1,694.57)	(0.01)	30.1311	0.0001	(0.01)	0.0001
CALDWELL	91.24	0.00	0.50	0.00	(955.45)	(0.00)	14.7111	0.0001	(0.00)	0.0001
WILSON	52.55	0.00	0.27	0.00	(229.66)	(0.00)	7.3226	0.0000	(0.00)	0.0000
HARDIN	96.97	0.00	0.47	0.00	(757.38)	(0.00)	10.4174	0.0000	(0.00)	0.0000
HARRISON	250.89	0.00	1.34	0.00	(1,463.49)	(0.01)	34.4608	0.0002	(0.01)	0.0002
WALLER	(9.12)	0.00	0.02	0.00	(349.04)	(0.00)	4.1497	0.0000	(0.00)	0.0000
UPSHUR	71.32	0.00	0.36	0.00	(628.50)	(0.00)	9.7221	0.0000	(0.00)	0.0000
RUSK	36.41	0.10	0.19	0.00	(234.82)	(0.00)	3.0692	0.0000	0.10	0.0000
HOOD	194.12	1.85	0.97	0.01	(1,516.58)	(0.01)	24.7175	0.0001	1.84	0.0117
HUNT	180.05	0.91	0.95	0.01	(1,482.58)	(0.01)	25.1534	0.0001	0.91	0.0061
HENDERSON	23.79	0.12	0.20	0.00	(596.83)	(0.00)	8.0105	0.0000	0.12	0.0009
HIDALGO	0.00	0.57	0.00	0.00	0.00	0.00	0.0000	0.0000	0.57	0.0045
CAMERON	869.30	0.15	5.95	0.00	(9,058.64)	(0.04)	188.0215	0.0009	0.11	0.0019
BELL	1,142.84		6.63		(3,500.49)	(0.02)	166.2135	0.0008	(0.02)	0.0008
WEBB	475.24	0.06	2.99	0.00	(4,793.57)	(0.02)	95.4114	0.0004	0.04	0.0007
BRAZOS	1,257.66	0.08	6.75	0.00	(6,038.87)	(0.03)	164.5281	0.0008	0.05	0.0012
KENDALL	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
BURNET	118.40		0.60		(817.79)	(0.00)	14.7725	0.0001	(0.00)	0.0001
GRAYSON	171.83		1.31		(2,921.80)	(0.01)	48.2176	0.0002	(0.01)	0.0002
CORYELL	138.91		0.74		(797.22)	(0.00)	16.9898	0.0001	(0.00)	0.0001
MIDLAND	542.85		2.86		(3,007.75)	(0.01)	61.7977	0.0003	(0.01)	0.0003
LLANO	154.63	0.07	0.84	0.00	258.16	0.00	17.7269	0.0001	0.08	0.0005
MAVERICK	166.13		0.86		(594.67)	(0.00)	19.2372	0.0001	(0.00)	0.0001
MCMULLEN	4.75		0.02		(47.70)	(0.00)	0.7804	0.0000	(0.00)	0.0000
ARANSAS	94.26		0.48		(322.84)	(0.00)	6.3511	0.0000	(0.00)	0.0000
WICHITA	604.08	0.03	3.36	0.00	(860.96)	(0.00)	74.3694	0.0003	0.03	0.0005
TAYLOR	348.40	0.00	2.05	0.00	(2,039.52)	(0.01)	46.9692	0.0002	(0.01)	0.0002
TOM GREEN	531.44	0.00	2.94	0.00	(1,993.03)	(0.01)	69.8041	0.0003	(0.00)	0.0003
MCLENNAN	716.71	3.63	4.25	0.02	(5,732.60)	(0.03)	119.1497	0.0005	3.60	0.0222
MCCULLOCH	12.71		0.06		(128.25)	(0.00)	1.8157	0.0000	(0.00)	0.0000
WISE	230.64	0.42	1.20	0.00	(783.05)	(0.00)	29.7724	0.0001	0.42	0.0029
JIM HOGG	13.20		0.07		(103.68)	(0.00)	1.8182	0.0000	(0.00)	0.0000
VAL VERDE	83.12		0.44		(556.17)	(0.00)	11.0468	0.0001	(0.00)	0.0001
ECTOR	36.41	0.52	1.37	0.00	(2,976.83)	(0.01)	75.5946	0.0003	0.51	0.0038
WHARTON	104.22	0.01	0.58	0.00	(749.43)	(0.00)	11.7001	0.0001	0.01	0.0001
KERR	316.10		1.64		(1,117.78)	(0.01)	37.2239	0.0002	(0.01)	0.0002
PRESIDIO	10.07	0.00	0.05	0.00	(111.05)	(0.00)	1.6685	0.0000	(0.00)	0.0000
JIM WELLS	159.19		0.83		(654.11)	(0.00)	16.8164	0.0001	(0.00)	0.0001
CALHOUN	65.08	0.25	0.32	0.00	(339.08)	(0.00)	4.5336	0.0000	0.25	0.0017
GILLESPIE	57.61		0.32		(330.36)	(0.00)	6.8808	0.0000	(0.00)	0.0000
MATAGORDA	54.56		0.31		(429.55)	(0.00)	8.8432	0.0000	(0.00)	0.0000
NAVARRO	42.57		0.38		(831.30)	(0.00)	14.2773	0.0001	(0.00)	0.0001
ANGELINA	297.83	0.05	1.55	0.00	(1,563.52)	(0.01)	32.6956	0.0002	0.04	0.0005
NACOGDOCHES	266.10		1.40		(1,955.59)	(0.01)	37.2371	0.0002	(0.01)	0.0002
FANNIN	42.40	1.04	0.23	0.01	(401.49)	(0.00)	7.0140	0.0000	1.04	0.0072
ATASCOSA	92.07		0.48		(531.79)	(0.00)	10.8745	0.0001	(0.00)	0.0001
WASHINGTON	156.73		0.91		(1,510.26)	(0.01)	24.3865	0.0001	(0.01)	0.0001
LAMAR	57.89	0.14	0.29	0.00	(487.28)	(0.00)	7.5558	0.0000	0.14	0.0010
VAN ZANDT	54.15		0.26		(546.83)	(0.00)	7.7830	0.0000	(0.00)	0.0000
WILLACY	114.07		0.59		(926.25)	(0.00)	12.2181	0.0001	(0.00)	0.0001
BROWN	61.93		0.35		(309.46)	(0.00)	8.6414	0.0000	(0.00)	0.0000
ERATH	66.38		0.34		(434.57)	(0.00)	9.0519	0.0000	(0.00)	0.0000
AUSTIN	(390.53)		(1.02)		(2,364.49)	(0.01)	22.5802	0.0001	(0.01)	0.0001
COOKE	370.05		2.01		(1,439.19)	(0.01)	43.4710	0.0002	(0.01)	0.0002
MEDINA	32.18		0.16		(331.43)	(0.00)	4.7642	0.0000	(0.00)	0.0000
TITUS	58.91	0.84	0.29	0.00	(482.46)	(0.00)	6.7923	0.0000	0.84	0.0000
UVALDE	147.69		0.77		(1,067.38)	(0.00)	15.9190	0.0001	(0.00)	0.0001
FAYETTE	60.82	0.00	0.32	0.00	(101.09)	(0.00)	7.1002	0.0000	(0.00)	0.0000
CALLAHAN	24.93		0.13		(289.08)	(0.00)	4.1038	0.0000	(0.00)	0.0000
HOPKINS	41.69		0.27		(480.26)	(0.00)	7.9627	0.0000	(0.00)	0.0000
LAMPASAS	61.17		0.31		(215.24)	(0.00)	5.2426	0.0000	(0.00)	0.0000
BLANCO	22.50		0.11		(227.09)	(0.00)	3.1854	0.0000	(0.00)	0.0000
FREESTONE	11.54	0.54	0.06	0.00	(100.65)	(0.00)	1.5995	0.0000	0.54	0.0036
GRIMES	15.01	0.00	0.07	0.00	(151.15)	(0.00)	2.2690	0.0000	(0.00)	0.0002
LEE	19.22		0.09		(195.36)	(0.00)	2.7102	0.0000	(0.00)	0.0000
SOMERVELL	8.57		0.05		(94.88)	(0.00)	1.5048	0.0000	(0.00)	0.0000
ANDREWS	14.87	0.00	0.08	0.00	(52.97)	(0.00)	1.9120	0.0000	0.00	0.0000
BORDEN	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000

Table 54: 2008 Annual and OSD NOx Reductions from IECC / IRC by PCA for Commercial Buildings by County using 2007 eGRID (w/7% T&D) (2)

	Electricity Savings and Resultant NOx Reductions (Office)				Total Natural Gas Savings and Resultant NOx Reductions (Office)				Total Nox Reductions	
County	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Total OSD N.G. Savings (Therm/County)	OSD Nox Reductions (Tons)	Annual Nox Reductions (Tons)	OSD Nox Reductions (Tons)
CHEROKEE	142.54	0.52	0.90	0.00	(1,547.94)	(0.01)	31.1095	0.0001	0.51	0.0034
DIMMIT	3.30		0.02		(33.28)	(0.00)	0.4658	0.0000	(0.00)	0.0000
FALLS	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
COLORADO	29.94		0.15		(180.94)	(0.00)	3.9411	0.0000	(0.00)	0.0000
FRIO	35.78	0.04	0.18	0.00	(226.18)	(0.00)	3.9418	0.0000	0.04	0.0004
MILAM	80.45	0.33	0.39	0.00	(654.82)	(0.00)	8.9810	0.0000	0.33	0.0016
JACKSON	23.53		0.11		(238.20)	(0.00)	3.3656	0.0000	(0.00)	0.0000
ANDERSON	9.93		0.06		(53.65)	(0.00)	1.2800	0.0000	(0.00)	0.0000
HILL	94.92		0.47		(751.70)	(0.00)	11.6207	0.0001	(0.00)	0.0001
CULBERSON	12.74		0.06		(122.62)	(0.00)	1.7390	0.0000	(0.00)	0.0000
MASON	1.40		0.01		(14.15)	(0.00)	0.1980	0.0000	(0.00)	0.0000
PECOS	35.26	0.01	0.19	0.00	(43.89)	(0.00)	4.3556	0.0000	0.01	0.0001
RAINS	11.27		0.05		(113.66)	(0.00)	1.6221	0.0000	(0.00)	0.0000
LAVACA	17.43		0.09		(147.61)	(0.00)	2.7190	0.0000	(0.00)	0.0000
PALO PINTO	81.78	0.13	0.41	0.00	(559.59)	(0.00)	8.4726	0.0000	0.12	0.0008
KIMBLE	3.27		0.02		(32.81)	(0.00)	0.5427	0.0000	(0.00)	0.0000
MADISON	13.45		0.07		(137.12)	(0.00)	1.9408	0.0000	(0.00)	0.0000
ARCHER	27.95		0.15		(219.01)	(0.00)	4.5461	0.0000	(0.00)	0.0000
REFUGIO	2.94		0.01		(29.53)	(0.00)	0.4695	0.0000	(0.00)	0.0000
LIMESTONE	42.97	0.04	0.22	0.00	(191.05)	(0.00)	3.8181	0.0000	0.04	0.0000
CLAY	4.85		0.02		(48.94)	(0.00)	0.7043	0.0000	(0.00)	0.0000
BEE	157.10		0.80		(814.84)	(0.00)	20.2548	0.0001	(0.00)	0.0001
MARTIN	0.57		0.00		(5.71)	(0.00)	0.0798	0.0000	(0.00)	0.0000
GONZALES	11.71		0.06		(52.67)	(0.00)	1.3354	0.0000	(0.00)	0.0000
BURLESON	23.78		0.12		(152.26)	(0.00)	3.1040	0.0000	(0.00)	0.0000
KARNES	11.83		0.06		(72.20)	(0.00)	1.5391	0.0000	(0.00)	0.0000
KLEBERG	162.28		0.81		(885.16)	(0.00)	14.6575	0.0001	(0.00)	0.0001
BREWSTER	21.07		0.14		(212.07)	(0.00)	5.0098	0.0000	(0.00)	0.0000
WINKLER	1.87		0.01		(18.77)	(0.00)	0.3078	0.0000	(0.00)	0.0000
FRANKLIN	(60.37)		(0.17)		(265.58)	(0.00)	2.1303	0.0000	(0.00)	0.0000
YOUNG	114.75	0.92	0.58	0.01	(649.34)	(0.00)	11.1089	0.0001	0.92	0.0052
HOUSTON	71.75		0.37		(229.47)	(0.00)	5.3631	0.0000	(0.00)	0.0000
SCURRY	(9.87)		0.01		(150.12)	(0.00)	2.1370	0.0000	(0.00)	0.0000
BOSQUE	22.05	0.02	0.11	0.00	(222.43)	(0.00)	3.1612	0.0000	0.02	0.0003
COMANCHE	214.95		1.17		120.32	0.00	25.7620	0.0001	0.00	0.0001
BRISCOE	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
CONCHO	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
ZAVALA	8.11		0.04		(50.20)	(0.00)	1.1488	0.0000	(0.00)	0.0000
NOLAN	76.87	0.08	0.39	0.00	(355.33)	(0.00)	7.9234	0.0000	0.08	0.0006
BROOKS	1.96		0.01		(6.94)	(0.00)	0.1526	0.0000	(0.00)	0.0000
ROBERTSON	6.46	0.12	0.04	0.00	(60.83)	(0.00)	1.3647	0.0000	0.12	0.0004
LIVE OAK	18.89		0.10		(189.33)	(0.00)	3.1874	0.0000	(0.00)	0.0000
HAMILTON	15.81		0.08		(43.85)	(0.00)	1.9854	0.0000	(0.00)	0.0000
JONES	16.51	0.12	0.10	0.00	(292.11)	(0.00)	4.2667	0.0000	0.12	0.0008
REAGAN	3.35		0.02		(22.11)	(0.00)	0.5182	0.0000	(0.00)	0.0000
WARD	(0.16)	2.74	(0.00)	0.02	(0.67)	(0.00)	0.0051	0.0000	2.74	0.0186
RED RIVER	20.43	0.00	0.10	0.00	(204.99)	(0.00)	2.9510	0.0000	(0.00)	0.0000
HASKELL	23.54	0.00	0.12	0.00	(100.50)	(0.00)	1.1324	0.0000	(0.00)	0.0000
HOWARD	34.92	0.08	0.18	0.00	(162.60)	(0.00)	4.4691	0.0000	0.08	0.0006
SAN SABA	13.10		0.07		(120.10)	(0.00)	1.8775	0.0000	(0.00)	0.0000
JACK	3.51	0.31	0.02	0.00	(35.30)	(0.00)	0.5599	0.0000	0.31	0.0020
STEPHENS	10.06		0.05		(64.44)	(0.00)	1.3366	0.0000	(0.00)	0.0000
RUNNELS	9.67		0.05		(85.37)	(0.00)	1.1696	0.0000	(0.00)	0.0000
REEVES	21.45		0.11		(77.51)	(0.00)	2.8505	0.0000	(0.00)	0.0000
DE WITT	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
CHILDRESS	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
CROSBY	3.07		0.02		(8.69)	(0.00)	0.4184	0.0000	(0.00)	0.0000
DAWSON	9.20		0.04		(92.82)	(0.00)	1.3196	0.0000	(0.00)	0.0000
MITCHELL	18.59	2.21	0.10	0.02	(17.13)	(0.00)	2.3714	0.0000	2.21	0.0159
WILBARGER	58.43	0.09	0.31	0.00	(141.37)	(0.00)	5.9603	0.0000	0.09	0.0000
COLEMAN	5.38	0.00	0.03	0.00	(29.20)	(0.00)	0.7142	0.0000	0.00	0.0000
UPTON	0.30	0.00	0.00	0.00	1.40	0.00	0.0321	0.0000	0.00	0.0000
COKE	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0000	0.00	0.0000
CROCKETT	7.47	0.00	0.04	0.00	(75.01)	(0.00)	1.2045	0.0000	(0.00)	0.0000
HARDEMAN	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0000	0.00	0.0000
BANDERA	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
BAYLOR	6.42		0.03		5.68	0.00	0.7453	0.0000	0.00	0.0000
COTTLE	1.92		0.01		(19.40)	(0.00)	0.2715	0.0000	(0.00)	0.0000
CRANE	4.55		0.02		(45.77)	(0.00)	0.7180	0.0000	(0.00)	0.0000
DELTA	3.74		0.02		(37.73)	(0.00)	0.5398	0.0000	(0.00)	0.0000
DICKENS	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
DUVAL	28.49		0.14		(271.94)	(0.00)	3.8267	0.0000	(0.00)	0.0000
EASTLAND	72.55		0.36		(395.74)	(0.00)	5.4903	0.0000	(0.00)	0.0000
EDWARDS	0.87		0.00		(8.72)	(0.00)	0.1299	0.0000	(0.00)	0.0000
FISHER	8.67		0.04		(22.68)	(0.00)	1.0766	0.0000	(0.00)	0.0000
FOARD	0.32		0.00		(3.23)	(0.00)	0.0543	0.0000	(0.00)	0.0000
GLASSCOCK	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
GOLIAD	5.51		0.03		(55.64)	(0.00)	0.7787	0.0000	(0.00)	0.0000
HALL	0.68		0.00		(6.85)	(0.00)	0.0958	0.0000	(0.00)	0.0000
HUDSPETH	12.13		0.06		(122.36)	(0.00)	1.7459	0.0000	(0.00)	0.0000
IRION	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
JEFF DAVIS	11.69		0.06		(117.17)	(0.00)	1.9674	0.0000	(0.00)	0.0000
KENEDY	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
KENT	5.26		0.03		24.68	0.00	0.5656	0.0000	0.00	0.0000
KING	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
KINNEY	5.07		0.02		(44.15)	(0.00)	0.6034	0.0000	(0.00)	0.0000
KNOX	3.13		0.02		(31.44)	(0.00)	0.4840	0.0000	(0.00)	0.0000
LA SALLE	5.94		0.03		(4.90)	(0.00)	0.6259	0.0000	(0.00)	0.0000
LEON	20.75		0.10		(210.45)	(0.00)	3.2963	0.0000	(0.00)	0.0000
LOVING	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
MENARD	2.62		0.01		(18.86)	(0.00)	0.3694	0.0000	(0.00)	0.0000
MILLS	13.08		0.06		(131.80)	(0.00)	1.9292	0.0000	(0.00)	0.0000
MONTAGUE	56.19		0.29		(239.42)	(0.00)	5.3501	0.0000	(0.00)	0.0000
MOTLEY	0.80		0.00		(8.10)	(0.00)	0.1134	0.0000	(0.00)	0.0000
REAL	8.59		0.05		17.96	0.00	1.1277	0.0000	0.00	0.0000
SCHLEICHER	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
SHACKELFORD	13.06		0.07		(59.51)	(0.00)	1.7701	0.0000	(0.00)	0.0000
STARR	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
STERLING	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
STONEWALL	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
SUTTON	4.58		0.02		(9.46)	(0.00)	0.5625	0.0000	(0.00)	0.0000
TERRELL	0.00		0.00		0.00	0.00	0.0000	0.0000	0.00	0.0000
THROCKMORTON	1.85		0.01		(18.56)	(0.00)	0.3125	0.0000	(0.00)	0.0000
ZAPATA	60.01		0.29		(548.18)	(0.00)	8.2846	0.0000	(0.00)	0.0000
TOTAL	**60,824.84**	**41.35**	**394.99**	**0.26**	**(617,226.62)**	**(2.84)**	**11,365.77**	**0.05**	**38.51**	**0.31**



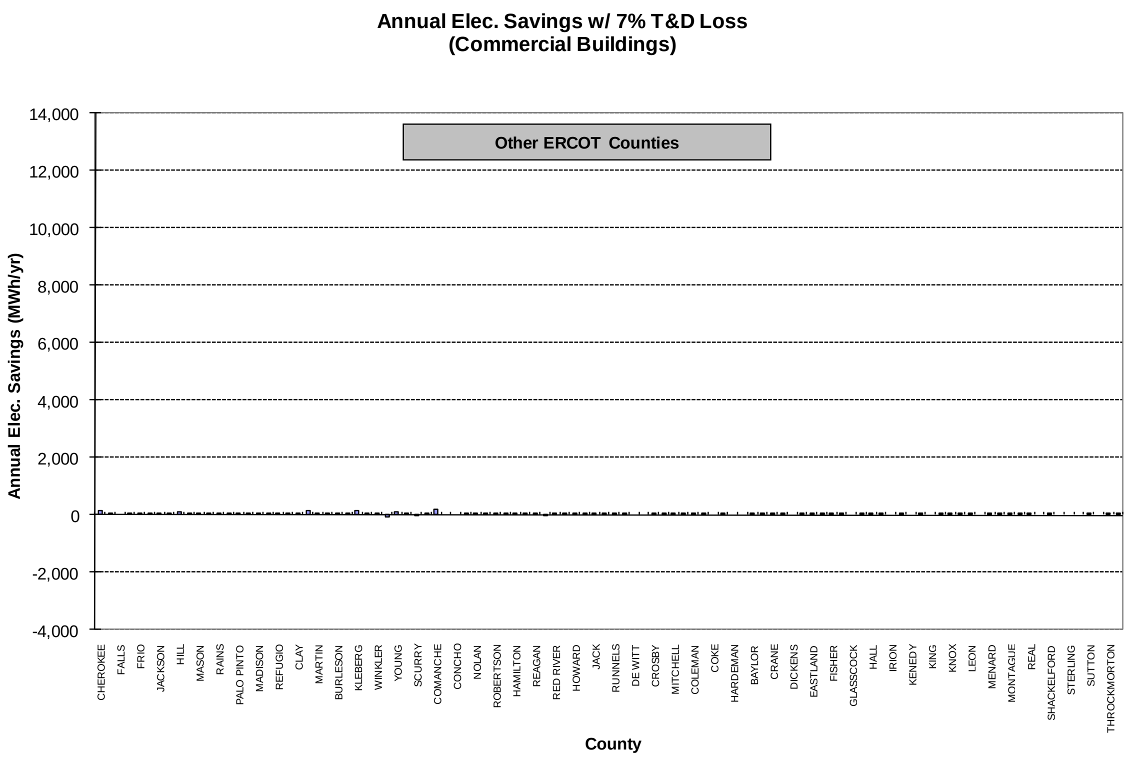
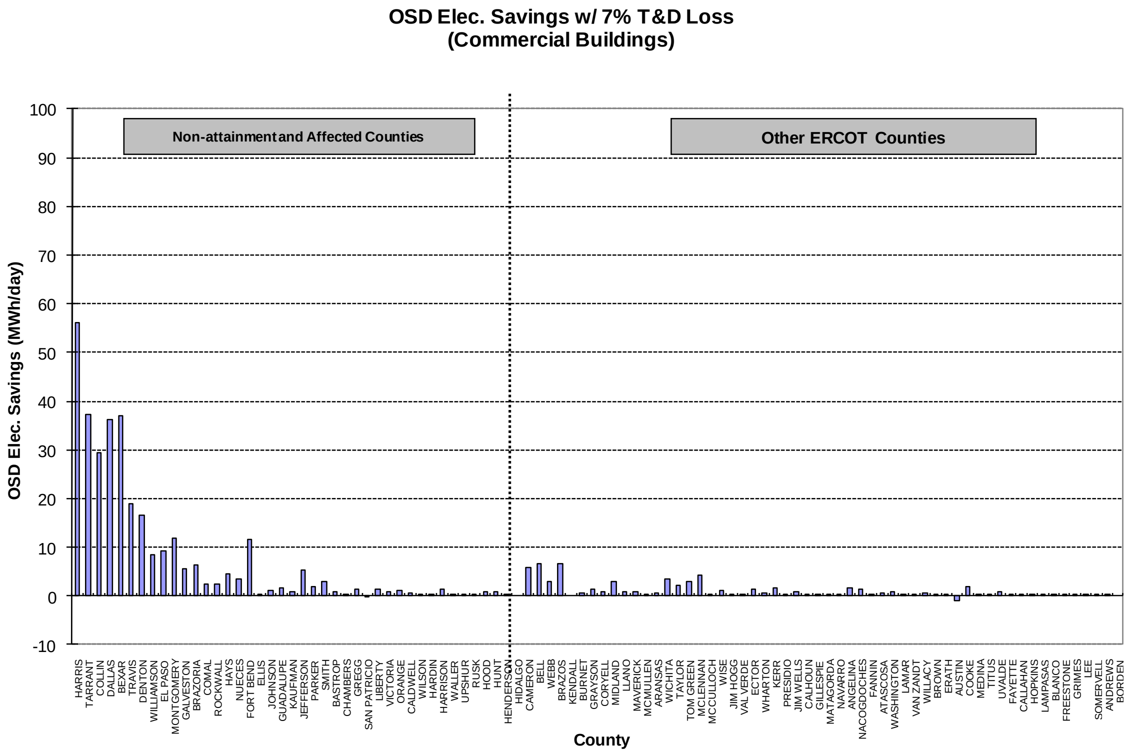


Figure 88: 2009 Annual Electricity Reductions from IECC/IRC by PCA for Commercial Buildings with 7% T&D losses



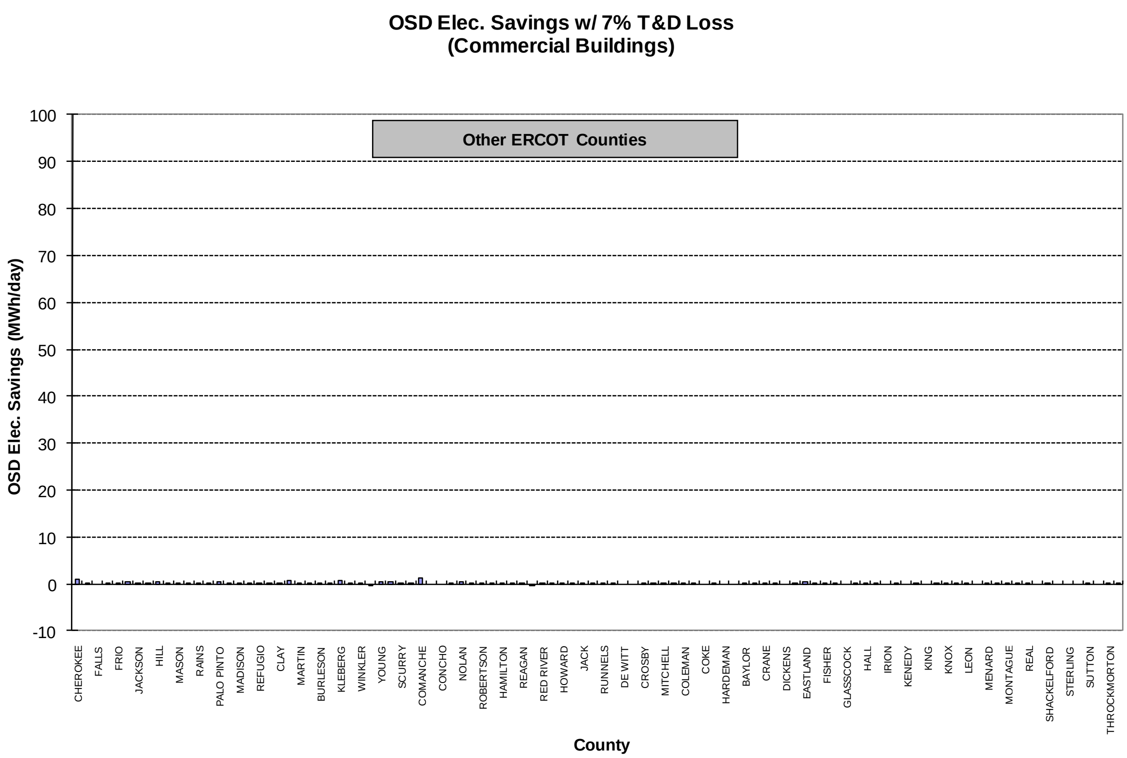
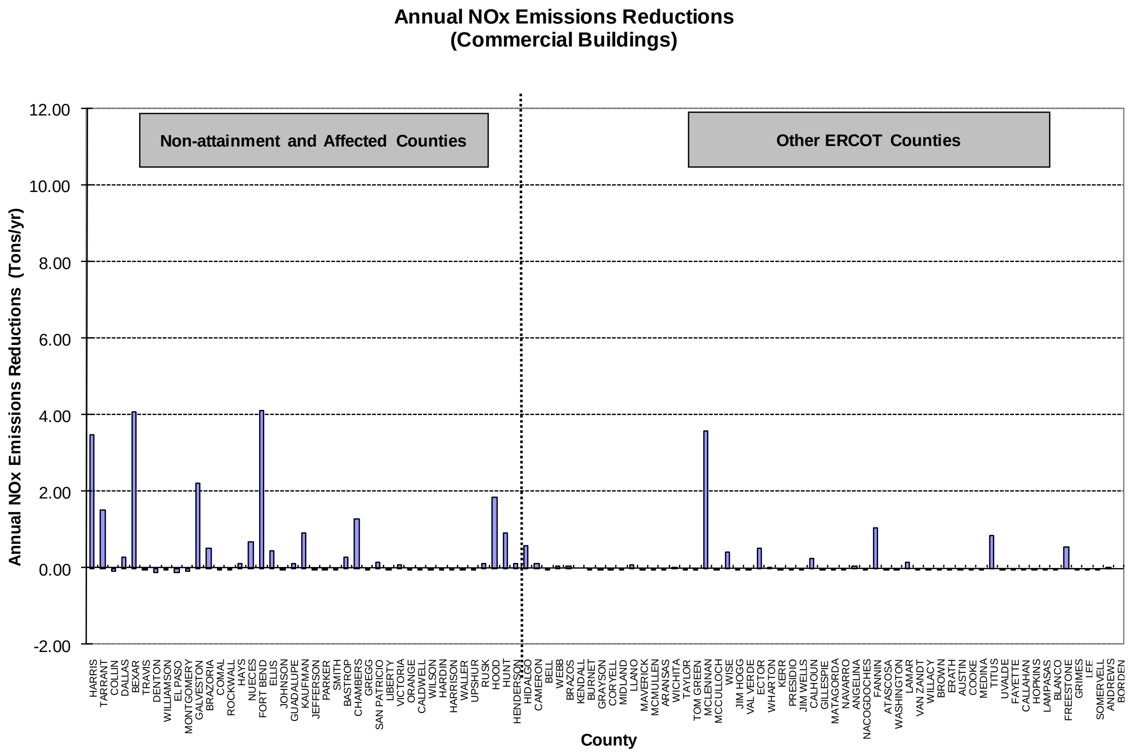


Figure 89: 2009 OSD Electricity Reductions from IECC/IRC by PCA for Commercial Buildings with 7% T&D losses



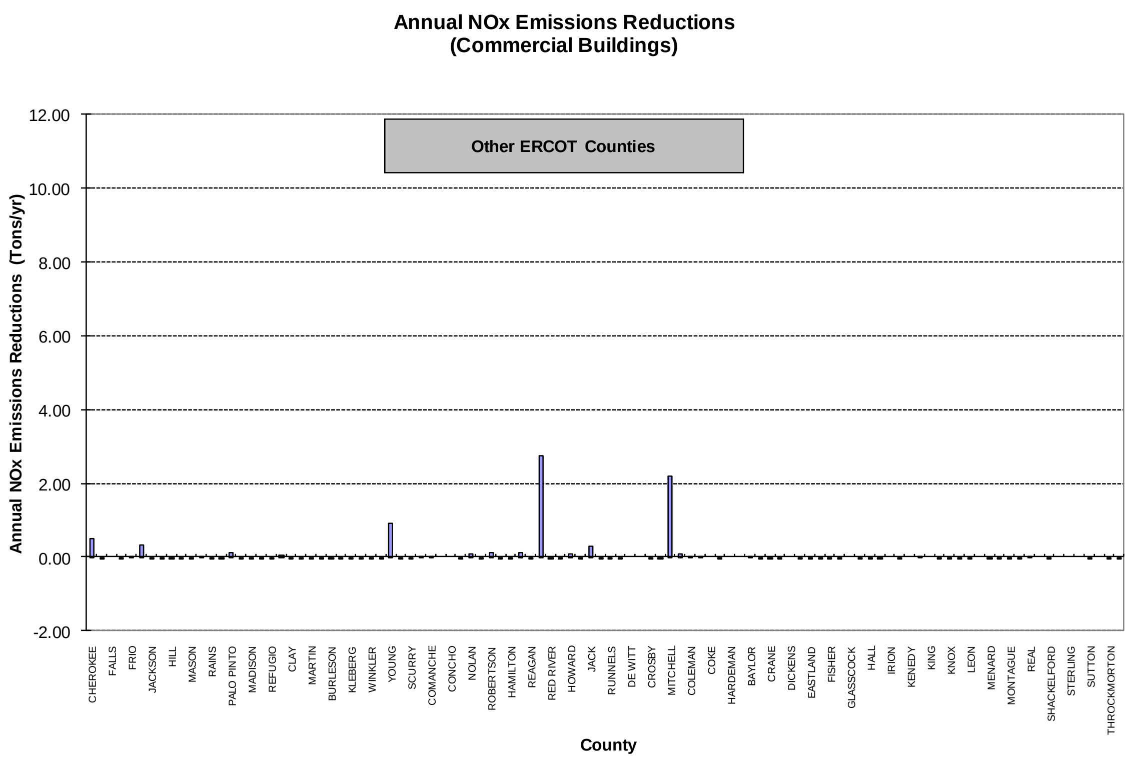
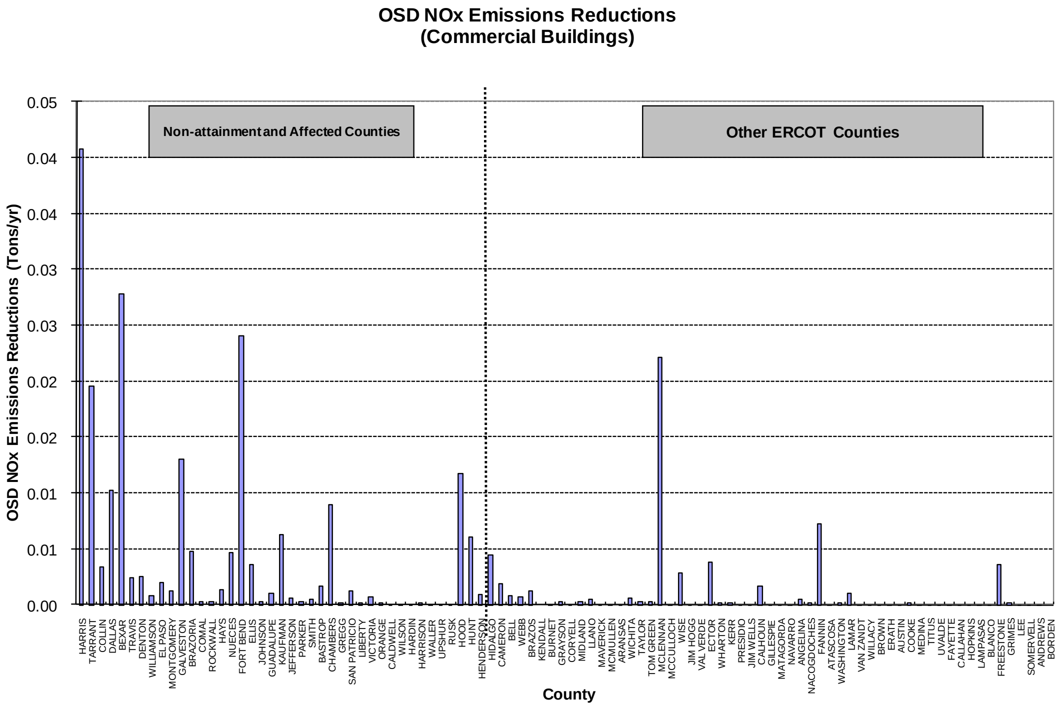


Figure 90: Annual NOx Reductions from Electricity Savings from the IECC / IRC by PCA for Commercial Buildings by County using 2007 eGRID with 7% T&D losses.



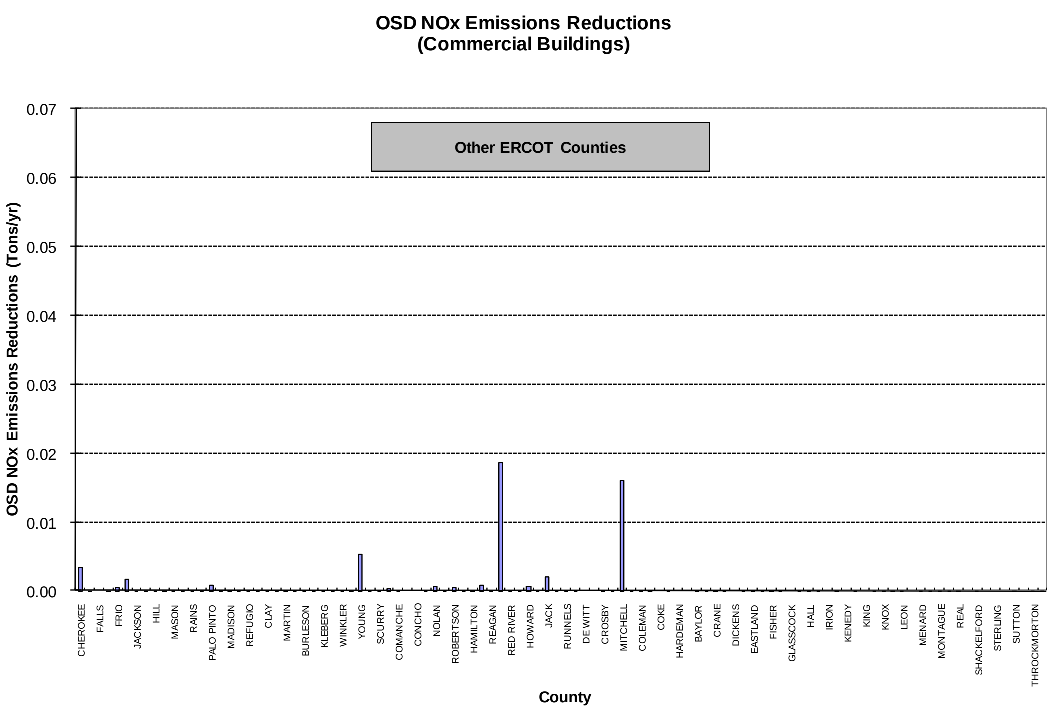


Figure 91: 2009 OSD NOx Reductions from Electricity Savings from the IECC/IRC by PCA for Commercial Buildings by County using 2007 eGRID with 7% T&D losses

6.1.6 2009 Results for New Residential (Single-family and Multi-family), and Commercial Construction using 2007 eGRID.

As shown in Table 55 and Table 56 , the total annual electricity savings in 2009 were calculated to be 280,995.4 MWh/yr [1] which includes 85,311.81 MWh/yr (i.e., 30.4%) for single-family residential, 134,858.75 MWh/yr (i.e., 48.0%) for multi-family residential, and 60,824 MWh/yr (i.e., 21.6%) for new commercial buildings. Natural gas savings were calculated to be 330,120 MMBtu (3,301,202 therms) for new residential and commercial construction.

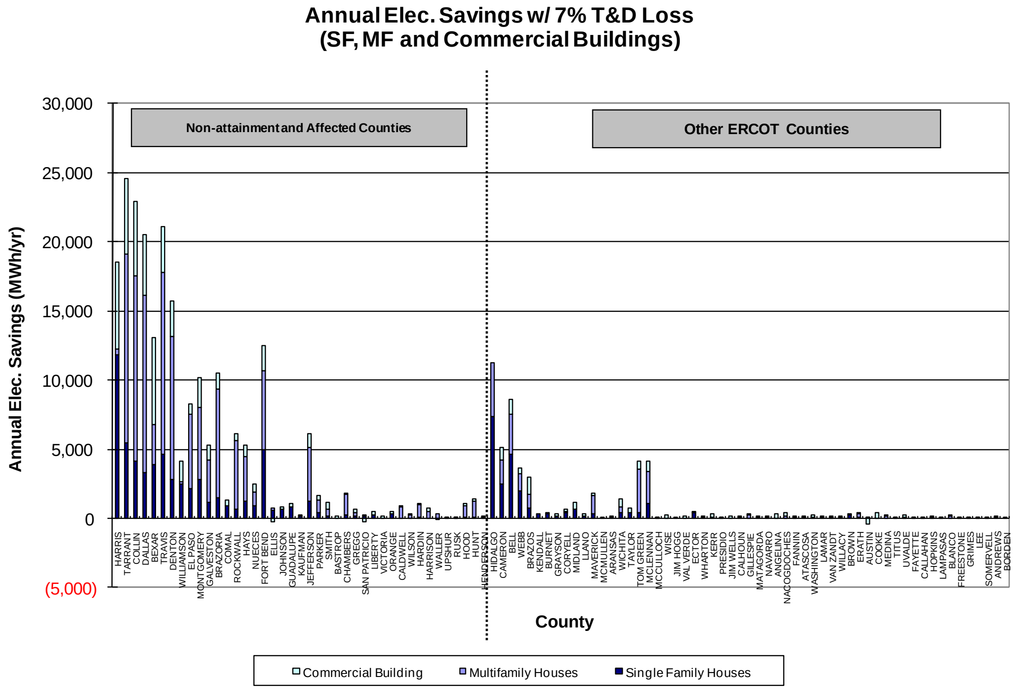
Using the 2009 eGRID, the total NOx reductions from electricity and natural gas savings from new residential (single-family and multi-family) and commercial construction in 2008 were calculated to be 189.67 tons NOx/year which represents 187.73 tons NOx/year from electricity savings and 1.94 tons NOx/year from natural gas savings. On a peak Ozone Season Day (OSD), the NOx reductions in 2008 are calculated to be 1.12 tons of NOx/day which represents 1.06 tons NOx/day from electricity savings and 0.06 tons NOx/day from natural gas savings.

Table 55: 2009 Annual and OSD NOx Reductions from Electricity and Natural Gas Savings Due to the IECC / IRC for Single-family and Multi-family Residences and for Commercial Buildings by County (using 2007 eGRID) (Part 1)

	Electricity Savings and Resultant NOx Reductions (Single Family Houses)				Electricity Savings and Resultant NOx Reductions (Multifamily Houses)				Electricity Savings and Resultant NOx Reductions (Commercial Buildings)				Total Electricity Savings and Resultant NOx Reductions (SF, MF and Commecial Buildings)				Total Natural Gas Savings and Resultant NOx Reductions (SF, MF and Commecial Buildings)				Total Nox Reductions	
County	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Total OSD N.G. Savings (Therm/County)	OSD Nox Reductions (Tons)	Annual Nox Reductions (Tons)	OSD Nox Reductions (Tons)
HARRIS	11,837.49	6.56	82.08	0.05	373.99	8.38	1.66	0.04	6,364.77	4.07	56.08	0.03	18,576.24	19.01	139.82	0.13	(26,234.76)	(0.12)	2,254.69	0.01	18.89	0.14
TARRANT	5,468.22	2.08	42.57	0.02	13,648.50	4.51	67.51	0.03	5,479.22	1.80	37.25	0.01	24,595.94	8.40	147.32	0.06	37,489.03	0.17	1,174.65	0.01	8.57	0.07
COLLIN	4,183.28	0.11	32.45	0.00	13,398.32	0.21	64.58	0.00	5,364.78	0.09	29.46	0.00	22,946.38	0.41	126.49	0.00	48,801.48	0.22	685.73	0.00	0.63	0.01
DALLAS	3,307.88	0.76	25.75	0.01	12,825.11	1.65	63.43	0.01	4,373.06	0.66	36.35	0.00	20,506.05	3.07	125.53	0.02	(12,984.99)	(0.06)	1,288.62	0.01	3.01	0.03
BEXAR	3,889.57	3.68	27.93	0.02	2,907.18	2.36	14.20	0.01	6,304.29	4.27	36.95	0.02	13,101.03	10.31	79.07	0.06	5,233.88	0.02	1,031.13	0.00	10.33	0.06
TRAVIS	4,664.05	0.08	33.30	0.00	13,144.60	0.15	65.79	0.00	3,273.24	0.06	18.98	0.00	21,081.89	0.28	118.07	0.00	34,939.78	0.16	521.75	0.00	0.45	0.00
DENTON	2,848.99	0.03	22.88	0.00	10,304.94	0.05	49.67	0.00	2,548.74	0.02	16.60	0.00	15,702.67	0.09	89.15	0.00	48,623.64	0.22	556.72	0.00	0.31	0.00
WILLIAMSON	2,503.37	0.00	17.87	0.00	124.16	0.00	0.62	0.00	1,549.60	0.00	8.35	0.00	4,177.13	0.00	26.85	0.00	8,461.12	0.04	223.07	0.00	0.04	0.00
EL PASO	2,187.74	0.00	13.60	0.00	5,327.54	0.00	17.09	0.00	730.98	0.00	9.20	0.00	8,246.27	0.00	39.89	0.00	43,258.25	0.20	481.65	0.00	0.20	0.00
MONTGOMERY	2,831.97	0.00	19.64	0.00	5,196.43	0.00	23.02	0.00	2,179.97	0.00	11.97	0.00	10,208.37	0.00	54.63	0.00	18,629.97	0.09	308.90	0.00	0.09	0.00
GALVESTON	1,162.22	3.43	8.06	0.02	3,093.32	4.66	13.70	0.02	1,067.06	2.23	5.70	0.01	5,322.61	10.32	27.46	0.05	9,456.14	0.04	136.64	0.00	10.36	0.05
BRAZORIA	1,525.16	0.89	10.57	0.01	7,826.60	1.19	34.67	0.01	1,149.37	0.57	6.26	0.00	10,501.14	2.65	51.51	0.02	17,622.97	0.08	174.08	0.00	2.73	0.02
COMAL	886.29	0.00	6.36	0.00	0.00	0.00	0.00	0.00	465.37	0.00	2.48	0.00	1,351.66	0.00	8.84	0.00	6,113.35	0.03	72.28	0.00	0.03	0.00
ROCKWALL	628.88	0.00	5.05	0.00	5,029.12	0.00	24.24	0.00	470.71	0.00	2.50	0.00	6,128.70	0.00	31.79	0.00	20,296.42	0.09	66.04	0.00	0.09	0.00
HAYS	1,285.45	0.21	9.18	0.00	3,153.71	0.41	15.79	0.00	843.73	0.15	4.53	0.00	5,282.89	0.77	29.50	0.00	7,348.23	0.03	119.99	0.00	0.80	0.00
NUECES	931.20	1.90	5.57	0.01	988.24	1.90	4.18	0.01	563.49	0.69	3.60	0.00	2,482.94	4.49	13.35	0.02	3,636.47	0.02	126.63	0.00	4.51	0.02
FORT BEND	4,948.03	6.77	34.31	0.04	5,708.20	8.65	25.29	0.03	1,842.29	4.20	11.59	0.02	12,498.52	19.61	71.19	0.09	32,109.99	0.15	395.74	0.00	19.76	0.09
ELLIS	581.73	0.56	4.53	0.00	187.95	1.22	0.93	0.01	(242.80)	0.48	0.23	0.00	526.87	2.26	5.68	0.01	1,652.55	0.01	79.94	0.00	2.27	0.01
JOHNSON	630.71	0.02	4.91	0.00	35.80	0.03	0.18	0.00	191.18	0.01	1.23	0.00	857.70	0.05	6.31	0.00	4,621.83	0.02	49.50	0.00	0.08	0.00
GUADALUPE	872.34	0.17	6.26	0.00	0.00	0.34	0.00	0.00	199.95	0.12	1.69	0.00	1,072.28	0.63	7.95	0.00	4,720.69	0.02	77.40	0.00	0.65	0.00
KAUFMAN	156.93	1.08	1.26	0.01	0.00	2.35	0.00	0.01	105.93	0.93	0.88	0.01	262.87	4.37	2.14	0.03	(123.04)	(0.00)	41.07	0.00	4.37	0.03
JEFFERSON	1,230.02	0.00	8.37	0.00	3,933.23	0.00	17.27	0.00	945.30	0.00	5.26	0.00	6,108.54	0.00	30.90	0.00	15,230.43	0.07	145.00	0.00	0.07	0.00
PARKER	385.40	0.01	3.10	0.00	920.42	0.02	4.44	0.00	391.05	0.01	2.00	0.00	1,696.87	0.04	9.53	0.00	7,248.27	0.03	49.47	0.00	0.07	0.00
SMITH	149.61	0.00	1.17	0.00	540.89	0.00	2.45	0.00	446.30	0.00	3.07	0.00	1,136.80	0.00	6.69	0.00	52.32	0.00	97.82	0.00	0.00	0.00
BASTROP	29.47	0.38	0.21	0.00	0.00	0.76	0.00	0.00	140.26	0.27	0.78	0.00	169.73	1.41	0.99	0.01	(54.74)	(0.00)	22.63	0.00	1.41	0.01
CHAMBERS	261.35	2.09	1.78	0.01	1,506.59	2.67	6.62	0.01	89.87	1.30	0.44	0.01	1,857.80	6.06	8.84	0.04	4,107.90	0.02	14.11	0.00	6.08	0.04
GREGG	144.75	0.00	1.15	0.00	303.51	0.00	1.37	0.00	237.31	0.00	1.50	0.00	685.57	0.00	4.02	0.00	2,886.69	0.01	48.51	0.00	0.01	0.00
SAN PATRICIO	186.71	0.42	1.12	0.00	40.75	0.42	0.17	0.00	(269.26)	0.15	(0.18)	0.00	(41.79)	0.99	1.10	0.01	(2,528.47)	(0.01)	45.30	0.00	0.98	0.01
LIBERTY	236.62	0.00	1.64	0.00	0.00	0.00	0.00	0.00	281.73	0.00	1.38	0.00	518.35	0.00	3.02	0.00	(474.24)	(0.00)	39.72	0.00	(0.00)	0.00
VICTORIA	40.55	0.22	0.29	0.00	0.00	0.26	0.00	0.00	146.48	0.10	0.80	0.00	187.03	0.57	1.09	0.00	(325.29)	(0.00)	17.86	0.00	0.57	0.00
ORANGE	325.41	0.00	2.22	0.00	0.00	0.00	0.00	0.00	207.00	0.00	1.10	0.00	532.41	0.00	3.32	0.00	1,020.28	0.00	36.03	0.00	0.00	0.00
CALDWELL	25.41	0.00	0.18	0.00	792.46	0.00	0.00	0.00	91.24	0.00	0.50	0.00	909.10	0.00	0.68	0.00	(761.00)	(0.00)	15.11	0.00	(0.00)	0.00
WILSON	28.97	0.00	0.21	0.00	238.54	0.00	1.16	0.00	52.55	0.00	0.27	0.00	320.06	0.00	1.64	0.00	475.77	0.00	7.87	0.00	0.00	0.00
HARDIN	128.53	0.00	0.87	0.00	835.33	0.00	3.67	0.00	96.97	0.00	0.47	0.00	1,060.83	0.00	5.02	0.00	1,762.57	0.01	12.75	0.00	0.01	0.00
HARRISON	37.36	0.00	0.30	0.00	438.72	0.00	1.96	0.00	250.89	0.00	1.34	0.00	726.98	0.00	3.60	0.00	757.74	0.00	35.22	0.00	0.00	0.00
WALLER	6.13	0.00	0.04	0.00	295.25	0.00	1.31	0.00	(9.12)	0.00	0.02	0.00	292.26	0.00	1.37	0.00	255.28	0.00	4.26	0.00	0.00	0.00
UPSHUR	9.35	0.00	0.07	0.00	0.00	0.00	0.00	0.00	71.32	0.00	0.36	0.00	80.67	0.00	0.44	0.00	(462.00)	(0.00)	9.87	0.00	(0.00)	0.00
RUSK	4.67	0.12	0.04	0.00	19.74	0.25	0.08	0.00	36.41	0.10	0.19	0.00	60.81	0.47	0.31	0.00	(94.00)	(0.00)	3.18	0.00	0.47	0.00
HOOD	50.21	2.15	0.39	0.02	877.08	4.65	4.34	0.02	194.12	1.85	0.97	0.01	1,121.42	8.65	5.70	0.05	1,088.44	0.01	25.55	0.00	8.65	0.05
HUNT	56.49	1.06	0.44	0.01	1,180.87	2.30	5.69	0.01	180.05	0.91	0.95	0.01	1,417.41	4.27	7.08	0.03	2,185.91	0.01	26.08	0.00	4.28	0.03
HENDERSON	45.40	0.14	0.36	0.00	22.08	0.30	0.10	0.00	23.79	0.12	0.20	0.00	91.26	0.57	0.66	0.00	371.01	0.00	8.94	0.00	0.57	0.00
HIDALGO	7,362.60	1.57	40.07	0.01	3,935.28	1.57	17.18	0.01	0.00	0.57	0.00	0.00	11,297.88	3.72	57.25	0.02	12,671.76	0.06	51.68	0.00	3.78	0.02
CAMERON	2,475.29	0.40	13.47	0.00	1,756.07	0.40	7.66	0.00	869.30	0.15	5.95	0.00	5,100.65	0.95	27.09	0.01	(4,322.02)	(0.02)	205.40	0.00	0.93	0.01
BELL	4,613.04		31.98		2,883.08		13.53		1,142.84	0.00	6.63	0.00	8,638.97	0.00	52.15	0.00	26,020.80	0.12	203.37	0.00	0.12	0.00
WEBB	1,994.12	0.17	10.43	0.00	1,202.19	0.17	5.09	0.00	475.24	0.06	2.99	0.00	3,671.55	0.39	18.51	0.00	245.66	0.00	108.89	0.00	0.40	0.00
BRAZOS	722.03	0.10	5.01	0.00	1,043.22	0.19	4.62	0.00	1,257.66	0.08	6.75	0.00	3,022.91	0.37	16.38	0.00	1,966.74	0.01	177.61	0.00	0.38	0.00
KENDALL	307.01		2.02		0.00		0.00		0.00	0.00	0.00	0.00	307.01	0.00	2.02	0.00	1,856.66	0.01	2.99	0.00	0.01	0.00
BURNET	299.39		2.14		0.00		0.00		118.40	0.00	0.60	0.00	417.79	0.00	2.74	0.00	1,449.78	0.01	19.52	0.00	0.01	0.00
GRAYSON	132.63		1.03		47.23		0.23		171.83	0.00	1.31	0.00	351.69	0.00	2.56	0.00	(1,215.15)	(0.01)	50.40	0.00	(0.01)	0.00
CORYELL	415.95		2.88		113.06		0.53		138.91	0.00	0.74	0.00	667.92	0.00	4.15	0.00	1,522.29	0.01	20.34	0.00	0.01	0.00
MIDLAND	638.15		3.60		0.00		0.00		542.85	0.00	2.86	0.00	1,181.01	0.00	6.46	0.00	7,751.96	0.04	68.46	0.00	0.04	0.00
LLANO	173.26	0.10	1.24	0.00	16.55	0.21	0.08	0.00	154.63	0.07	0.84	0.00	344.45	0.39	2.16	0.00	1,590.10	0.01	20.47	0.00	0.39	0.00
MAVERICK	301.51		1.58		1,324.45		5.61		166.13	0.00	0.86	0.00	1,792.09	0.00	8.04	0.00	1,653.91	0.01	21.28	0.00	0.01	0.00
MCMULLEN	0.00		0.00		0.00		0.00		4.75	0.00	0.02	0.00	4.75	0.00	0.02	0.00	(47.70)	(0.00)	0.78	0.00	(0.00)	0.00
ARANSAS	113.90		0.68		0.00		0.00		94.26	0.00	0.48	0.00	208.16	0.00	1.16	0.00	429.81	0.00	8.15	0.00	0.00	0.00
WICHITA	395.19	0.04	2.55	0.00	417.33	0.08	1.58	0.00	604.08	0.03	3.36	0.00	1,416.61	0.14	7.49	0.00	10,219.42	0.05	77.62	0.00	0.19	0.00
TAYLOR	443.35	0.00	2.73	0.00	0.00	0.00	0.00	0.00	348.40	0.00	2.05	0.00	791.75	0.00	4.78	0.00	5,482.32	0.03	51.03	0.00	0.03	0.00
TOM GREEN	389.59	0.01	2.36	0.00	3,186.79	0.01	11.58	0.00	531.44	0.00	2.94	0.00	4,107.82	0.03	16.88	0.00	10,141.46	0.05	73.46	0.00	0.08	0.00
MCLENNAN	1,062.43	4.20	7.36	0.03	2,355.46	9.11	11.06	0.04	716.71	3.63	4.25	0.02	4,134.59	16.93	22.67	0.09	5,008.66	0.02	127.71	0.00	16.96	0.09
MCCULLOCH	2.15		0.01		0.00		0.00		12.71	0.00	0.06	0.00	14.86	0.00	0.07	0.00	(113.19)	(0.00)	1.84	0.00	(0.00)	0.00
WISE	39.46	0.49	0.31	0.00	0.00	1.05	0.00	0.01	230.64	0.42	1.20	0.00	270.10	1.96	1.50	0.01	(313.10)	(0.00)	30.42	0.00	1.95	0.01
JIM HOGG	0.00		0.00		0.00		0.00		13.20	0.00	0.07	0.00	13.20	0.00	0.07	0.00	(103.68)	(0.00)	1.82	0.00	(0.00)	0.00
VAL VERDE	47.21		0.34		0.00		0.00		83.12	0.00	0.44	0.00	130.34	0.00	0.77	0.00	(74.83)	(0.00)	11.93	0.00	(0.00)	0.00
ECTOR	425.44	0.61	2.40	0.00	0.00	1.31	0.00	0.01	36.41	0.52	1.37	0.00	461.84	2.44	3.77	0.01	4,196.31	0.02	80.04	0.00	2.46	0.01
WHARTON	61.70	0.01	0.43	0.00	0.00	0.02	0.00	0.00	104.22	0.01	0.58	0.00	165.92	0.04	1.01	0.00	(150.24)	(0.00)	13.00	0.00	0.04	0.00
KERR	58.60		0.42		0.00		0.00		316.10	0.00	1.64	0.00	374.71	0.00	2.06	0.00	(673.92)	(0.00)	38.15	0.00	(0.00)	0.00
PRESIDIO	10.76	0.00	0.07	0.00	0.00	0.00	0.00	0.00	10.07	0.00	0.05	0.00	20.83	0.00	0.12	0.00	(35.72)	(0.00)	1.77	0.00	(0.00)	0.00
JIM WELLS	12.92		0.08		0.00		0.00		159.19	0.00	0.83	0.00	172.10	0.00	0.90	0.00	(568.76)	(0.00)	17.02	0.00	(0.00)	0.00
CALHOUN	52.89	0.69	0.37	0.00	0.00	0.69	0.00	0.00	65.08	0.25	0.32	0.00	117.97	1.63	0.70	0.01	174.51	0.00	5.64	0.00	1.63	0.01
GILLESPIE	35.67		0.25		206.94		1.04		57.61	0.00	0.32	0.00	300.22	0.00	1.61	0.00	185.26	0.00	7.45	0.00	0.00	0.00
MATAGORDA	69.63		0.49		0.00		0.00		54.56	0.00	0.31	0.00	124.20	0.00	0.80	0.00	246.68	0.00	10.30	0.00	0.00	0.00
NAVARRO	52.62		0.36		0.00		0.00		42.57	0.00	0.38	0.00	95.19	0.00	0.75	0.00	(571.20)	(0.00)	14.70	0.00	(0.00)	0.00
ANGELINA	40.44	0.05	0.31	0.00	0.00	0.12	0.00	0.00	297.83	0.05	1.55	0.00	338.27	0.21	1.86	0.00	(960.61)	(0.00)	33.66	0.00	0.21	0.00
NACOGDOCHES	31.11		0.24		118.41		0.47		266.10	0.00	1.40	0.00	415.62	0.00	2.11	0.00	(1,064.30)	(0.00)	37.98	0.00	(0.00)	0.00
FANNIN	13.51	1.21	0.10	0.01	56.68	2.62	0.27	0.01	42.40	1.04	0.23	0.01	112.59	4.87	0.61	0.03	(96.21)	(0.00)	7.24	0.00	4.87	0.03
ATASCOSA	63.94		0.42		0.00		0.00		92.07	0.00	0.48	0.00	156.01	0.00	0.90	0.00	(473.17)	(0.00)	11.52	0.00	(0.00)	0.00
WASHINGTON	83.74		0.58		39.37		0.17		156.73	0.00	0.91	0.00	279.84	0.00	1.67	0.00	(734.63)	(0.00)	25.90	0.00	(0.00)	0.00
LAMAR	48.64	0.16	0.36	0.00	0.00	0.35	0.00	0.00	57.89	0.14	0.29	0.00	106.53	0.66	0.66	0.00	173.96	0.00	8.06	0.00	0.66	0.00
VAN ZANDT	16.03		0.12		94.89		0.46		54.15	0.00	0.26	0.00	165.07	0.00	0.84	0.00	(118.18)	(0.00)	8.05	0.00	(0.00)	0.00
WILLACY	65.90		0.36		0.00		0.00		114.07	0.00	0.59	0.00	179.98	0.00	0.95	0.00	(851.58)	(0.00)	12.68	0.00	(0.00)	0.00
BROWN	270.62		1.88		0.00		0.00		61.93	0.00	0.35	0.00	332.55	0.00	2.23	0.00	1,028.18	0.00	10.82	0.00	0.00	0.00
ERATH	68.38		0.42		229.44		0.83		66.38	0.00	0.34	0.00	364.20	0.00	1.59	0.00	1,469.80	0.01	9.68	0.00	0.01	0.00
AUSTIN	30.64		0.21		39.37		0.17		(390.53)	0.00	(1.02)	0.00	(320.53)	0.00	(0.63)	0.00	(2,033.97)	(0.01)	23.14	0.00	(0.01)	0.00
COOKE	34.39		0.27		0.00		0.00		370.05	0.00	2.01	0.00	404.43	0.00	2.27	0.00	(1,027.76)	(0.00)	44.04	0.00	(0.00)	0.00
MEDINA	15.02		0.11		119.27		0.58		32.18	0.00	0.16	0.00	166.47	0.00	0.85	0.00	26.76	0.00	5.05	0.00	0.00	0.00
TITUS	18.02	0.98	0.13	0.00	0.00	2.11	0.00	0.00	58.91	0.84	0.29	0.00	76.93	3.93	0.42	0.00	(237.56)	(0.00)	6.98	0.00	3.93	0.00
UVALDE	20.39		0.15		67.09		0.33		147.69	0.00	0.77	0.00	235.17	0.00	1.25	0.00	(744.20)	(0.00)	16.30	0.00	(0.00)	0.00
FAYETTE	5.11	0.00	0.04	0.00	0.00	0.00	0.00	0.00	60.82	0.00	0.32	0.00	65.92	0.00	0.36	0.00	(58.29)	(0.00)	7.19	0.00	(0.00)	0.00
CALLAHAN	26.47		0.16		0.00		0.00		24.93	0.00	0.13	0.00	51.40	0.00	0.29	0.00	159.99	0.00	4.35	0.00	0.00	0.00
HOPKINS	9.87		0.08		56.93		0.27		41.69	0.00	0.27	0.00	108.49	0.00	0.62	0.00	(218.93)	(0.00)	8.12	0.00	(0.00)	0.00
LAMPASAS	37.59		0.26		0.00		0.00		61.17	0.00	0.31	0.00	98.75	0.00	0.57	0.00	(29.46)	(0.00)	5.55	0.00	(0.00)	0.00
BLANCO	8.92		0.06		132.44		0.66		22.50	0.00	0.11	0.00	163.86	0.00	0.83	0.00	(2.47)	(0.00)	3.33	0.00	(0.00)	0.00
FREESTONE	12.53	0.63	0.09	0.00	0.00	1.36	0.00	0.01	11.54	0.54	0.06	0.00	24.07	2.54	0.14	0.02	(38.72)	(0.00)	1.70	0.00	2.54	0.02
GRIMES	15.32	0.00	0.11	0.00	0.00	0.00	0.00	0.00	15.01	0.00	0.07	0.00	30.33	0.00	0.18	0.00	(22.76)	(0.00)	2.55	0.00	(0.00)	0.00
LEE	8.89		0.06		0.00		0.00		19.22	0.00	0.09	0.00	28.12	0.00	0.16	0.00	(127.30)	(0.00)	2.85	0.00	(0.00)	0.00
SOMERVELL	35.52		0.28		0.00		0.00		8.57	0.00	0.05	0.00	44.08	0.00	0.32	0.00	333.40	0.00	2.09	0.00	0.00	0.00
ANDREWS	88.95	0.00	0.50	0.00	0.00	0.01	0.00	0.00	14.87	0.00	0.08	0.00	103.82	0.02	0.58	0.00	1,446.86	0.01	2.84	0.00	0.02	0.00
BORDEN	33.31		0.17		0.00		0.00		0.00	0.00	0.00	0.00	33.31	0.00	0.17	0.00	1,204.82	0.01	0.35	0.00	0.01	0.00

Table 56: 2009 Annual and OSD NOx Reductions from Electricity and Natural Gas Savings Due to the IECC / IRC for Single-family and Multi-family Residences and for Commercial Buildings by County (using 2007 eGRID) (Part 2)

	Electricity Savings and Resultant NOx Reductions (Single Family Houses)				Electricity Savings and Resultant NOx Reductions (Multifamily Houses)				Electricity Savings and Resultant NOx Reductions (Commercial Buildings)				Total Electricity Savings and Resultant NOx Reductions (SF, MF and Commercial Buildings)				Total Natural Gas Savings and Resultant NOx Reductions (SF, MF and Commercial Buildings)				Total Nox Reductions	
County	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	OSD Electricity Savings per County w/ 7% T&D Loss (MWh/County)	OSD Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Total OSD N.G. Savings (Therm/County)	OSD Nox Reductions (Tons)	Annual Nox Reductions (Tons)	OSD Nox Reductions (Tons)
CHEROKEE	7.78	0.60	0.06	0.00	98.68	1.30	0.39	0.01	142.54	0.52	0.90	0.00	248.99	2.42	1.35	0.01	(1,075.74)	(0.00)	31.29	0.00	2.41	0.01
DIMMIT	20.90		0.11		0.00		0.00		3.30	0.00	0.02	0.00	24.19	0.00	0.13	0.00	3.14	0.00	0.61	0.00	0.00	0.00
FALLS	10.02		0.07		0.00		0.00		0.00	0.00	0.00	0.00	10.02	0.00	0.07	0.00	49.54	0.00	0.08	0.00	0.00	0.00
COLORADO	12.26		0.08		0.00		0.00		29.94	0.00	0.15	0.00	42.19	0.00	0.24	0.00	(78.22)	(0.00)	4.16	0.00	(0.00)	0.00
FRIO	23.98	0.09	0.16	0.00	0.00	0.10	0.00	0.00	35.78	0.04	0.18	0.00	59.76	0.23	0.34	0.00	(204.20)	(0.00)	4.18	0.00	0.23	0.00
MILAM	5.09	0.38	0.03	0.00	19.68	0.83	0.09	0.00	80.45	0.33	0.39	0.00	105.22	1.55	0.51	0.01	(617.37)	(0.00)	9.02	0.00	1.55	0.01
JACKSON	6.17		0.04		0.00		0.00		23.53	0.00	0.11	0.00	29.70	0.00	0.16	0.00	(178.28)	(0.00)	3.50	0.00	(0.00)	0.00
ANDERSON	10.11		0.08		0.00		0.00		9.93	0.00	0.06	0.00	20.04	0.00	0.13	0.00	97.08	0.00	1.52	0.00	0.00	0.00
HILL	35.08		0.24		0.00		0.00		94.92	0.00	0.47	0.00	130.00	0.00	0.71	0.00	(578.30)	(0.00)	11.90	0.00	(0.00)	0.00
CULBERSON	16.84		0.09		0.00		0.00		12.74	0.00	0.06	0.00	29.59	0.00	0.15	0.00	69.00	0.00	1.92	0.00	0.00	0.00
MASON	3.82		0.03		0.00		0.00		1.40	0.00	0.01	0.00	5.22	0.00	0.03	0.00	14.80	0.00	0.26	0.00	0.00	0.00
PECOS	12.91	0.01	0.08	0.00	0.00	0.02	0.00	0.00	35.26	0.01	0.19	0.00	48.18	0.03	0.27	0.00	46.51	0.00	4.48	0.00	0.03	0.00
RAINS	3.70		0.03		0.00		0.00		11.27	0.00	0.05	0.00	14.97	0.00	0.08	0.00	(69.60)	(0.00)	1.68	0.00	(0.00)	0.00
LAVACA	10.70		0.07		0.00		0.00		17.43	0.00	0.09	0.00	28.13	0.00	0.16	0.00	(91.18)	(0.00)	2.83	0.00	(0.00)	0.00
PALO PINTO	13.23	0.17	0.08	0.00	0.00	0.31	0.00	0.00	81.78	0.13	0.41	0.00	95.01	0.61	0.49	0.00	(335.06)	(0.00)	8.59	0.00	0.61	0.00
KIMBLE	2.15		0.01		0.00		0.00		3.27	0.00	0.02	0.00	5.42	0.00	0.03	0.00	(17.75)	(0.00)	0.56	0.00	(0.00)	0.00
MADISON	12.26		0.08		0.00		0.00		13.45	0.00	0.07	0.00	25.70	0.00	0.15	0.00	(34.40)	(0.00)	2.16	0.00	(0.00)	0.00
ARCHER	22.09		0.14		0.00		0.00		27.95	0.00	0.15	0.00	50.04	0.00	0.29	0.00	315.53	0.00	4.73	0.00	0.00	0.00
REFUGIO	7.05		0.05		0.00		0.00		2.94	0.00	0.01	0.00	9.99	0.00	0.06	0.00	38.95	0.00	0.62	0.00	0.00	0.00
LIMESTONE	5.01	0.07	0.03	0.00	18.84	0.09	0.09	0.00	42.97	0.04	0.22	0.00	66.82	0.20	0.34	0.00	(122.36)	(0.00)	3.86	0.00	0.20	0.00
CLAY	4.91		0.03		0.00		0.00		4.85	0.00	0.02	0.00	9.76	0.00	0.06	0.00	69.85	0.00	0.74	0.00	0.00	0.00
BEE	3.53		0.02		0.00		0.00		157.10	0.00	0.80	0.00	160.62	0.00	0.83	0.00	(780.60)	(0.00)	20.33	0.00	(0.00)	0.00
MARTIN	1.93		0.01		0.00		0.00		0.57	0.00	0.00	0.00	2.50	0.00	0.01	0.00	26.90	0.00	0.10	0.00	0.00	0.00
GONZALES	1.07		0.01		0.00		0.00		11.71	0.00	0.06	0.00	12.78	0.00	0.07	0.00	(41.73)	(0.00)	1.36	0.00	(0.00)	0.00
BURLESON	12.26		0.08		0.00		0.00		23.78	0.00	0.12	0.00	36.04	0.00	0.20	0.00	(49.54)	(0.00)	3.33	0.00	(0.00)	0.00
KARNES	112.67		0.73		0.00		0.00		11.83	0.00	0.06	0.00	124.50	0.00	0.79	0.00	71.11	0.00	2.57	0.00	0.00	0.00
KLEBERG	72.32		0.40		0.00		0.00		162.28	0.00	0.81	0.00	234.60	0.00	1.22	0.00	(796.45)	(0.00)	15.21	0.00	(0.00)	0.00
BREWSTER	43.05		0.26		0.00		0.00		21.07	0.00	0.14	0.00	64.12	0.00	0.40	0.00	89.25	0.00	5.41	0.00	0.00	0.00
WINKLER	1.93		0.01		0.00		0.00		1.87	0.00	0.01	0.00	3.80	0.00	0.02	0.00	13.83	0.00	0.33	0.00	0.00	0.00
FRANKLIN	2.47		0.02		0.00		0.00		(60.37)	0.00	(0.17)	0.00	(57.90)	0.00	(0.16)	0.00	(236.21)	(0.00)	2.17	0.00	(0.00)	0.00
YOUNG	11.03	1.07	0.07	0.01	0.00	2.31	0.00	0.01	114.75	0.92	0.58	0.01	125.78	4.30	0.65	0.02	(462.23)	(0.00)	11.21	0.00	4.30	0.02
HOUSTON	2.33		0.02		0.00		0.00		71.75	0.00	0.37	0.00	74.08	0.00	0.38	0.00	(194.68)	(0.00)	5.42	0.00	(0.00)	0.00
SCURRY	5.26		0.03		0.00		0.00		(9.87)	0.00	0.01	0.00	(4.62)	0.00	0.04	0.00	40.11	0.00	2.19	0.00	0.00	0.00
BOSQUE	10.02	0.03	0.07	0.00	0.00	0.06	0.00	0.00	22.05	0.02	0.11	0.00	32.07	0.11	0.18	0.00	(172.88)	(0.00)	3.24	0.00	0.11	0.00
COMANCHE	7.52		0.05		0.00		0.00		214.95	0.00	1.17	0.00	222.47	0.00	1.22	0.00	157.48	0.00	25.82	0.00	0.00	0.00
BRISCOE	11.17		0.04		0.00		0.00		0.00	0.00	0.00	0.00	11.17	0.00	0.04	0.00	1,053.52	0.00	0.14	0.00	0.00	0.00
CONCHO	2.15		0.01		0.00		0.00		0.00	0.00	0.00	0.00	2.15	0.00	0.01	0.00	15.07	0.00	0.02	0.00	0.00	0.00
ZAVALA	23.88		0.12		0.00		0.00		8.11	0.00	0.04	0.00	31.99	0.00	0.17	0.00	(8.58)	(0.00)	1.31	0.00	(0.00)	0.00
NOLAN	2.21	0.10	0.01	0.00	0.00	0.21	0.00	0.00	76.87	0.08	0.39	0.00	79.08	0.39	0.40	0.00	(317.91)	(0.00)	7.94	0.00	0.39	0.00
BROOKS	10.54		0.06		0.00		0.00		1.96	0.00	0.01	0.00	12.51	0.00	0.07	0.00	5.00	0.00	0.23	0.00	0.00	0.00
ROBERTSON	8.17	0.13	0.06	0.00	29.53	0.26	0.13	0.00	6.46	0.12	0.04	0.00	44.16	0.52	0.23	0.00	62.94	0.00	1.51	0.00	0.52	0.00
LIVE OAK	9.39		0.06		0.00		0.00		18.89	0.00	0.10	0.00	28.28	0.00	0.15	0.00	(127.25)	(0.00)	3.34	0.00	(0.00)	0.00
HAMILTON	7.52		0.05		0.00		0.00		15.81	0.00	0.08	0.00	23.32	0.00	0.13	0.00	(6.69)	(0.00)	2.05	0.00	(0.00)	0.00
JONES	2.21	0.34	0.01	0.00	0.00	0.34	0.00	0.00	16.51	0.12	0.10	0.00	18.71	0.80	0.11	0.00	(254.69)	(0.00)	4.29	0.00	0.80	0.00
REAGAN	5.97		0.03		0.00		0.00		3.35	0.00	0.02	0.00	9.32	0.00	0.05	0.00	0.60	0.00	0.58	0.00	0.00	0.00
WARD	13.54	3.18	0.08	0.02	0.00	6.89	0.00	0.04	(0.16)	2.74	(0.00)	0.02	13.38	12.81	0.08	0.08	227.56	0.00	0.15	0.00	12.81	0.08
RED RIVER	12.61	0.00	0.09	0.00	0.00	0.00	0.00	0.00	20.43	0.00	0.10	0.00	33.05	0.00	0.19	0.00	(33.56)	(0.00)	3.08	0.00	(0.00)	0.00
HASKELL	2.21	0.00	0.01	0.00	31.29	0.00	0.11	0.00	23.54	0.00	0.12	0.00	57.04	0.00	0.24	0.00	38.41	0.00	1.15	0.00	0.00	0.00
HOWARD	3.87	0.10	0.02	0.00	0.00	0.21	0.00	0.00	34.92	0.08	0.18	0.00	38.79	0.38	0.20	0.00	(97.39)	(0.00)	4.51	0.00	0.38	0.00
SAN SABA	0.00		0.00		0.00		0.00		13.10	0.00	0.07	0.00	13.10	0.00	0.07	0.00	(120.10)	(0.00)	1.88	0.00	(0.00)	0.00
JACK	22.06	0.36	0.14	0.00	0.00	0.79	0.00	0.00	3.51	0.31	0.02	0.00	25.57	1.46	0.15	0.01	338.92	0.00	0.76	0.00	1.47	0.01
STEPHENS	0.00		0.00		0.00		0.00		10.06	0.00	0.05	0.00	10.06	0.00	0.05	0.00	(64.44)	(0.00)	1.34	0.00	(0.00)	0.00
RUNNELS	4.30		0.03		0.00		0.00		9.67	0.00	0.05	0.00	13.97	0.00	0.07	0.00	(55.24)	(0.00)	1.21	0.00	(0.00)	0.00
REEVES	1.93		0.01		0.00		0.00		21.45	0.00	0.11	0.00	23.39	0.00	0.12	0.00	(44.90)	(0.00)	2.87	0.00	(0.00)	0.00
DE WITT	0.00		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHILDRESS	10.52		0.05		0.00		0.00		0.00	0.00	0.00	0.00	10.52	0.00	0.05	0.00	380.47	0.00	0.11	0.00	0.00	0.00
CROSBY	0.00		0.00		0.00		0.00		3.07	0.00	0.02	0.00	3.07	0.00	0.02	0.00	(8.69)	(0.00)	0.42	0.00	(0.00)	0.00
DAWSON	10.52		0.05		0.00		0.00		9.20	0.00	0.04	0.00	19.72	0.00	0.10	0.00	287.65	0.00	1.43	0.00	0.00	0.00
MITCHELL	2.21	2.56	0.01	0.02	0.00	5.55	0.00	0.03	18.59	2.21	0.10	0.02	20.79	10.31	0.11	0.07	20.30	0.00	2.39	0.00	10.31	0.07
WILBARGER	2.45	0.24	0.02	0.00	0.00	0.24	0.00	0.00	58.43	0.09	0.31	0.00	60.88	0.56	0.33	0.00	(81.98)	(0.00)	5.98	0.00	0.56	0.00
COLEMAN	2.25	0.01	0.01	0.00	0.00	0.01	0.00	0.00	5.38	0.00	0.03	0.00	7.63	0.03	0.04	0.00	(14.24)	(0.00)	0.73	0.00	0.03	0.00
UPTON	1.99	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.30	0.00	0.00	0.00	2.29	0.02	0.01	0.00	8.97	0.00	0.05	0.00	0.02	0.00
COKE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CROCKETT	40.90	0.00	0.25	0.00	0.00	0.00	0.00	0.00	7.47	0.00	0.04	0.00	48.37	0.00	0.29	0.00	211.24	0.00	1.59	0.00	0.00	0.00
HARDEMAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BANDERA	2.07		0.01		0.00		0.00		0.00	0.00	0.00	0.00	2.07	0.00	0.01	0.00	12.54	0.00	0.02	0.00	0.00	0.00
BAYLOR	0.00		0.00		0.00		0.00		6.42	0.00	0.03	0.00	6.42	0.00	0.03	0.00	5.68	0.00	0.75	0.00	0.00	0.00
COTTLE	0.00		0.00		0.00		0.00		1.92	0.00	0.01	0.00	1.92	0.00	0.01	0.00	(19.40)	(0.00)	0.27	0.00	(0.00)	0.00
CRANE	0.00		0.00		0.00		0.00		4.55	0.00	0.02	0.00	4.55	0.00	0.02	0.00	(45.77)	(0.00)	0.72	0.00	(0.00)	0.00
DELTA	7.40		0.06		0.00		0.00		3.74	0.00	0.02	0.00	11.14	0.00	0.08	0.00	50.39	0.00	0.66	0.00	0.00	0.00
DICKENS	0.00		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DUVAL	0.00		0.00		0.00		0.00		28.49	0.00	0.14	0.00	28.49	0.00	0.14	0.00	(271.94)	(0.00)	3.83	0.00	(0.00)	0.00
EASTLAND	0.00		0.00		0.00		0.00		72.55	0.00	0.36	0.00	72.55	0.00	0.36	0.00	(395.74)	(0.00)	5.49	0.00	(0.00)	0.00
EDWARDS	0.00		0.00		0.00		0.00		0.87	0.00	0.00	0.00	0.87	0.00	0.00	0.00	(8.72)	(0.00)	0.13	0.00	(0.00)	0.00
FISHER	0.00		0.00		0.00		0.00		8.67	0.00	0.04	0.00	8.67	0.00	0.04	0.00	(22.68)	(0.00)	1.08	0.00	(0.00)	0.00
FOARD	0.00		0.00		0.00		0.00		0.32	0.00	0.00	0.00	0.32	0.00	0.00	0.00	(3.23)	(0.00)	0.05	0.00	(0.00)	0.00
GLASSCOCK	0.00		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GOLIAD	0.00		0.00		0.00		0.00		5.51	0.00	0.03	0.00	5.51	0.00	0.03	0.00	(55.64)	(0.00)	0.78	0.00	(0.00)	0.00
HALL	0.00		0.00		0.00		0.00		0.68	0.00	0.00	0.00	0.68	0.00	0.00	0.00	(6.85)	(0.00)	0.10	0.00	(0.00)	0.00
HUDSPETH	0.00		0.00		0.00		0.00		12.13	0.00	0.06	0.00	12.13	0.00	0.06	0.00	(122.36)	(0.00)	1.75	0.00	(0.00)	0.00
IRION	0.00		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JEFF DAVIS	0.00		0.00		0.00		0.00		11.69	0.00	0.06	0.00	11.69	0.00	0.06	0.00	(117.17)	(0.00)	1.97	0.00	(0.00)	0.00
KENEDY	0.00		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KENT	0.00		0.00		0.00		0.00		5.26	0.00	0.03	0.00	5.26	0.00	0.03	0.00	24.68	0.00	0.57	0.00	0.00	0.00
KING	0.00		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KINNEY	0.00		0.00		0.00		0.00		5.07	0.00	0.02	0.00	5.07	0.00	0.02	0.00	(44.15)	(0.00)	0.60	0.00	(0.00)	0.00
KNOX	0.00		0.00		0.00		0.00		3.13	0.00	0.02	0.00	3.13	0.00	0.02	0.00	(31.44)	(0.00)	0.48	0.00	(0.00)	0.00
LA SALLE	17.91		0.09		0.00		0.00		5.94	0.00	0.03	0.00	23.85	0.00	0.12	0.00	26.32	0.00	0.75	0.00	0.00	0.00
LEON	0.00		0.00		0.00		0.00		20.75	0.00	0.10	0.00	20.75	0.00	0.10	0.00	(210.45)	(0.00)	3.30	0.00	(0.00)	0.00
LOVING	0.00		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MENARD	0.00		0.00		0.00		0.00		2.62	0.00	0.01	0.00	2.62	0.00	0.01	0.00	(18.86)	(0.00)	0.37	0.00	(0.00)	0.00
MILLS	0.00		0.00		0.00		0.00		13.08	0.00	0.06	0.00	13.08	0.00	0.06	0.00	(131.80)	(0.00)	1.93	0.00	(0.00)	0.00
MONTAGUE	1.23		0.01		0.00		0.00		56.19	0.00	0.29	0.00	57.42	0.00	0.30	0.00	(224.73)	(0.00)	5.37	0.00	(0.00)	0.00
MOTLEY	0.00		0.00		0.00		0.00		0.80	0.00	0.00	0.00	0.80	0.00	0.00	0.00	(8.10)	(0.00)	0.11	0.00	(0.00)	0.00
REAL	0.00		0.00		0.00		0.00		8.59	0.00	0.05	0.00	8.59	0.00	0.05	0.00	17.96	0.00	1.13	0.00	0.00	0.00
SCHLEICHER	4.30		0.03		0.00		0.00		0.00	0.00	0.00	0.00	4.30	0.00	0.03	0.00	30.13	0.00	0.04	0.00	0.00	0.00
SHACKELFORD	0.00		0.00		0.00		0.00		13.06	0.00	0.07	0.00	13.06	0.00	0.07	0.00	(59.51)	(0.00)	1.77	0.00	(0.00)	0.00
STARR	5.27		0.03		0.00		0.00		0.00	0.00	0.00	0.00	5.27	0.00	0.03	0.00	5.97	0.00	0.04	0.00	0.00	0.00
STERLING	0.00		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STONEWALL	0.00		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUTTON	0.00		0.00		0.00		0.00		4.58	0.00	0.02	0.00	4.58	0.00	0.02	0.00	(9.46)	(0.00)	0.56	0.00	(0.00)	0.00
TERRELL	0.00		0.00		0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
THROCKMORTON	0.00		0.00		0.00		0.00		1.85	0.00	0.01	0.00	1.85	0.00	0.01	0.00	(18.56)	(0.00)	0.31	0.00	(0.00)	0.00
ZAPATA	0.00		0.00		0.00		0.00		60.01	0.00	0.29	0.00	60.01	0.00	0.29	0.00	(548.18)	(0.00)	8.28	0.00	(0.00)	0.00
TOTAL	**85,311.81**	**55.78**	**587.09**	**0.38**	**134,858.75**	**90.59**	**622.00**	**0.42**	**60,824.84**	**41.35**	**394.99**	**0.26**	**280,995.39**	**187.73**	**1,604.09**	**1.06**	**422,226.31**	**1.94**	**12,648.33**	**0.06**	**189.67**	**1.12**



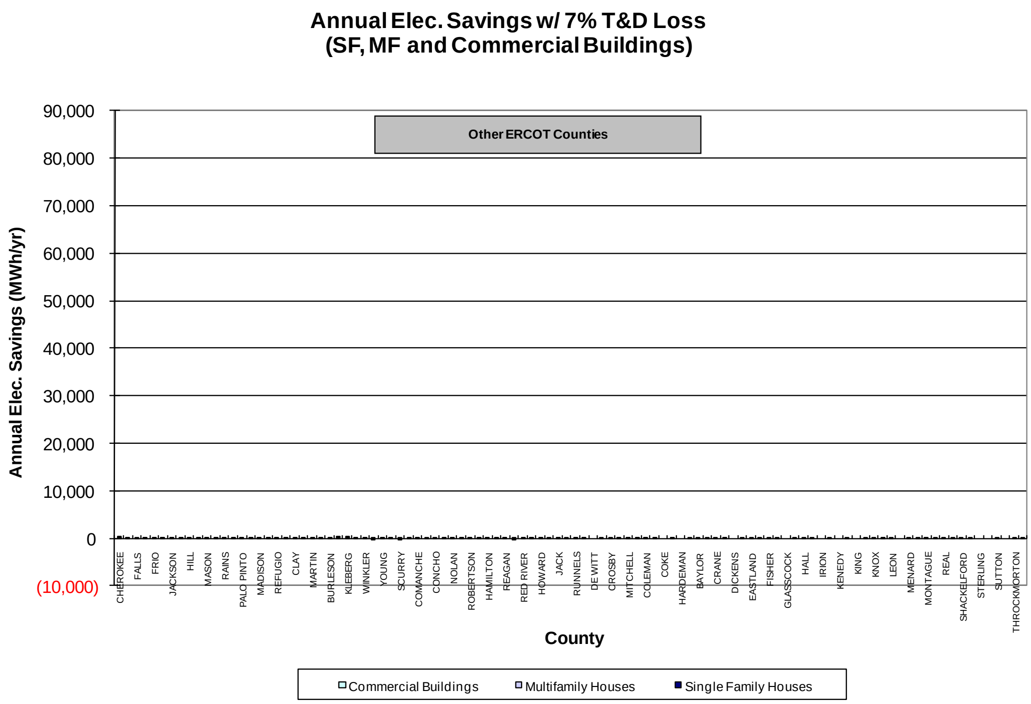
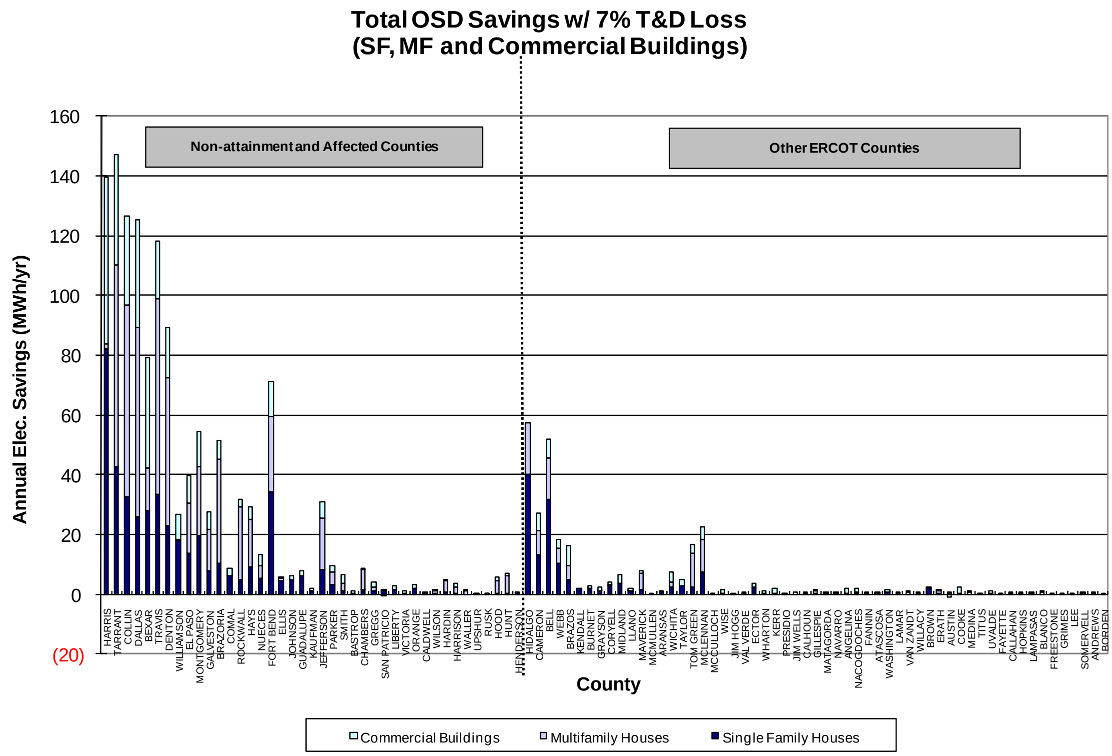


Figure 92: 2009 Annual Electricity Reductions from IECC/IRC by PCA for Single-family and Multi-family Residences and for Commercial Buildings by County



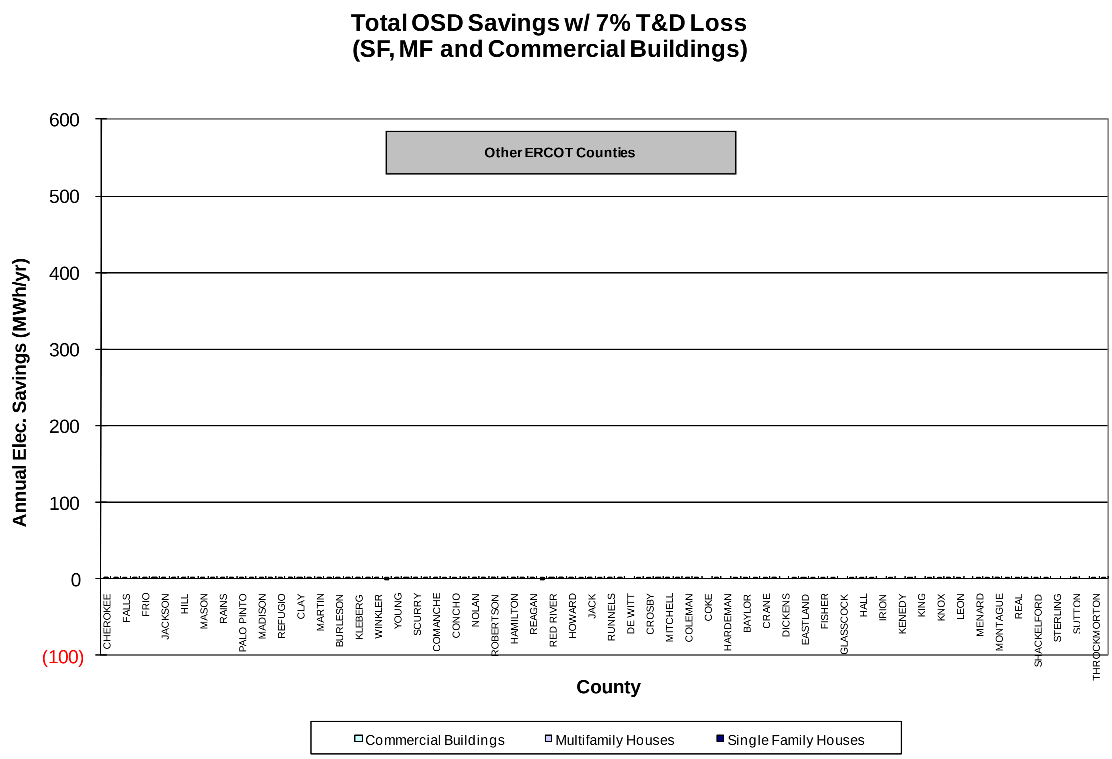
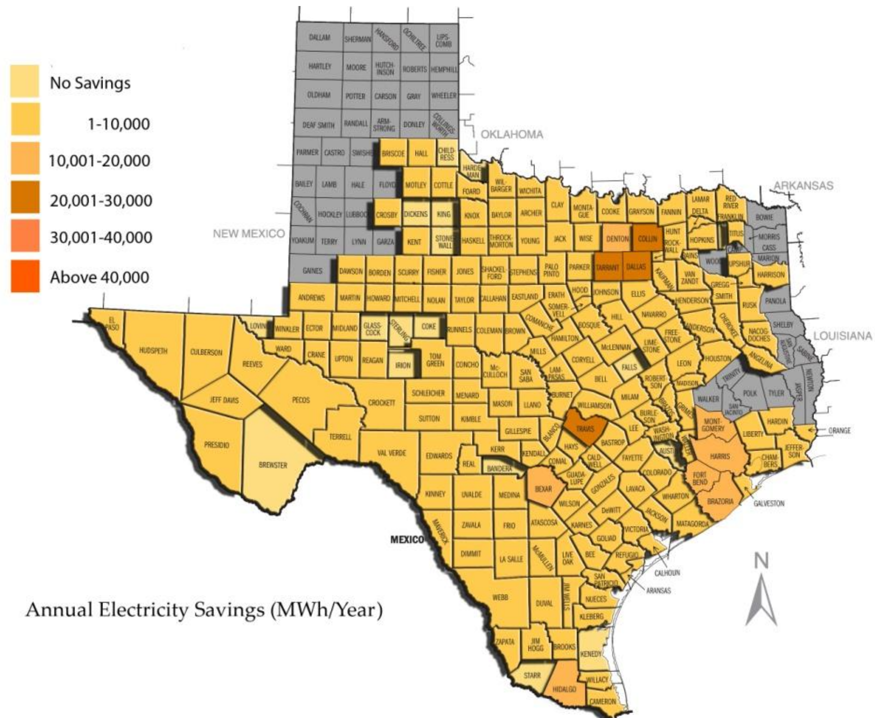


Figure 93: 2009 OSD Electricity Reductions from IECC/IRC by PCA for Single-family and Multi-family Residences and for Commercial Buildings by County



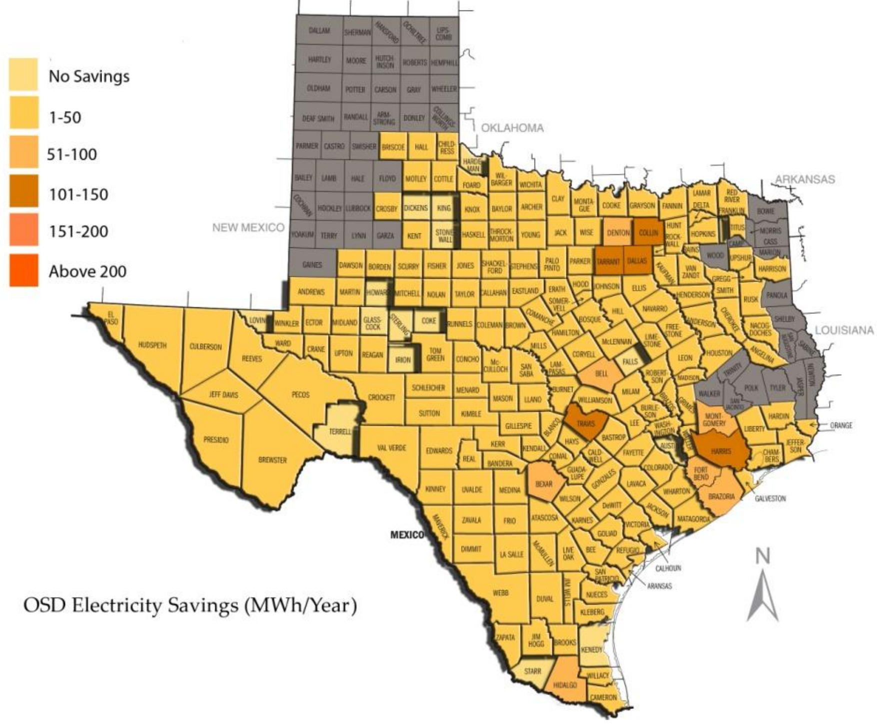
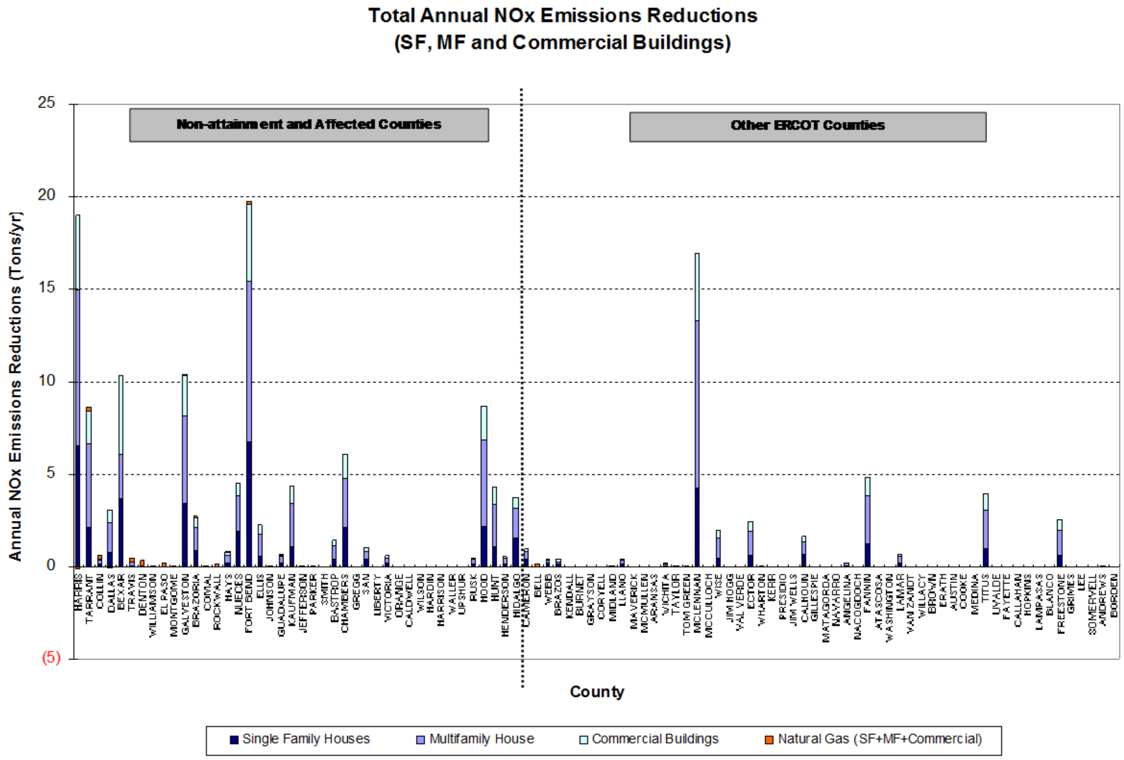


Figure 94: 2009 Annual and OSD Electricity Reductions from IECC/IRC by PCA for Single-family and Multi-family Residences and for Commercial Buildings by County



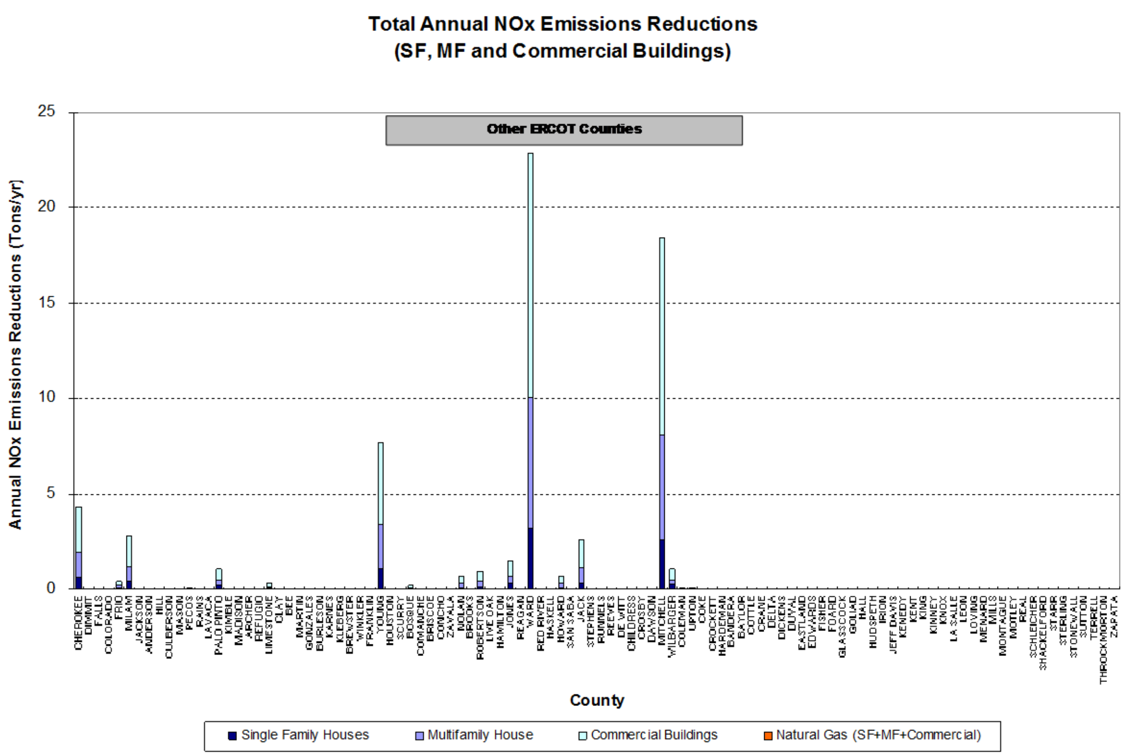
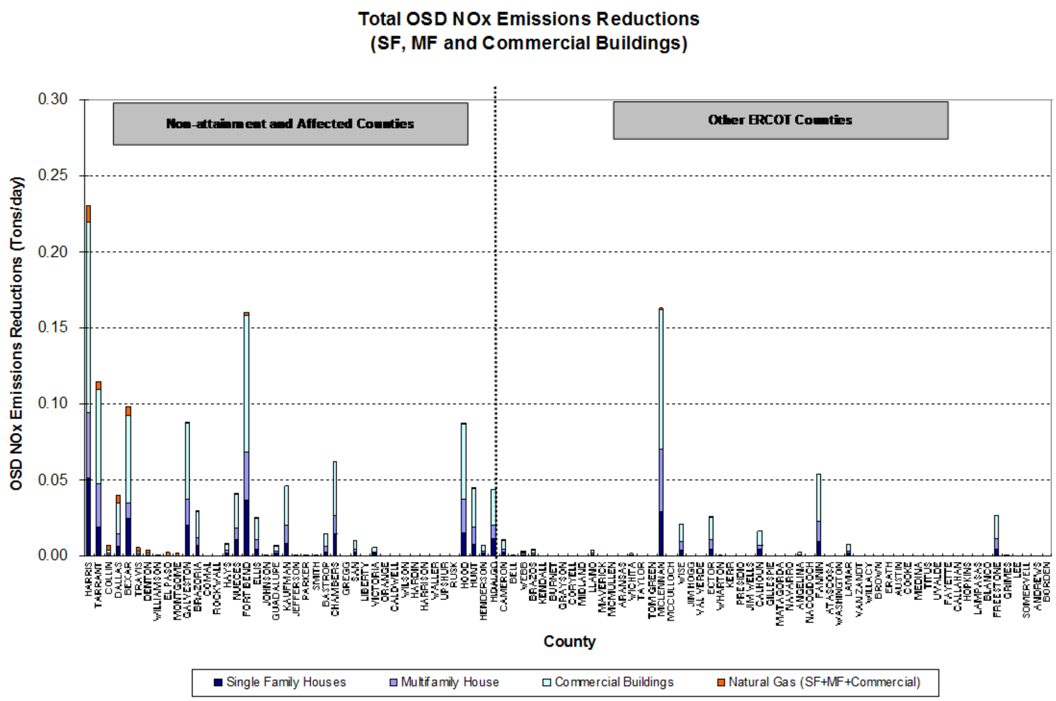


Figure 95: 2009 Annual NOx Reductions from Electricity and Natural Gas Savings Due to the IECC/IRC for Single-family and Multi-family Residences and for Commercial Buildings by County (using 1999 eGRID)



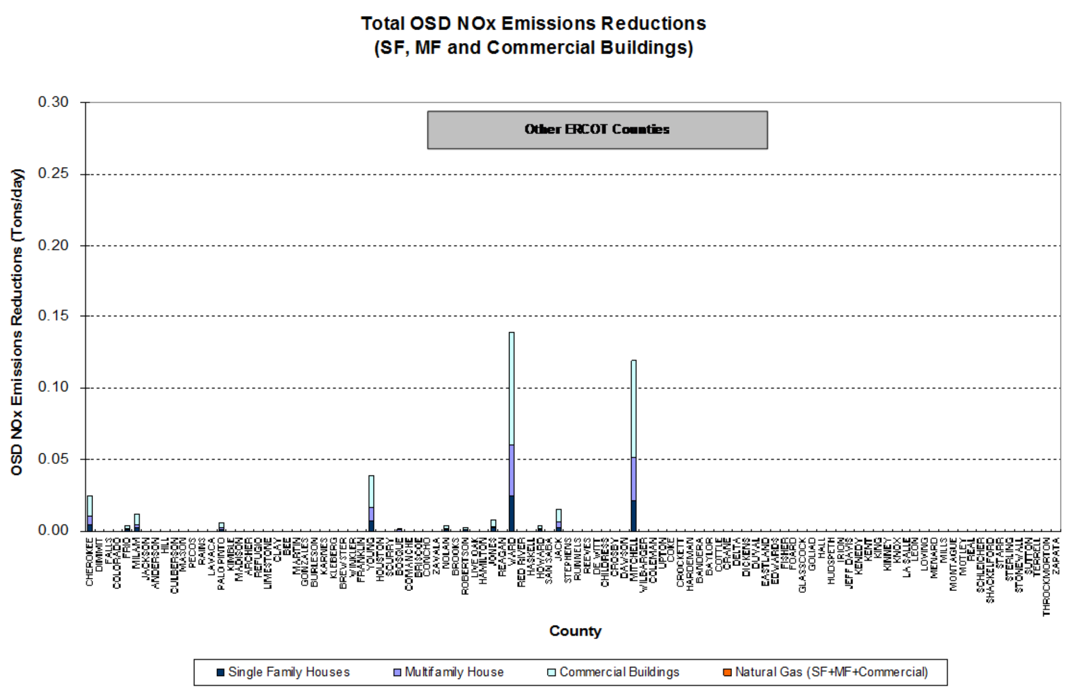
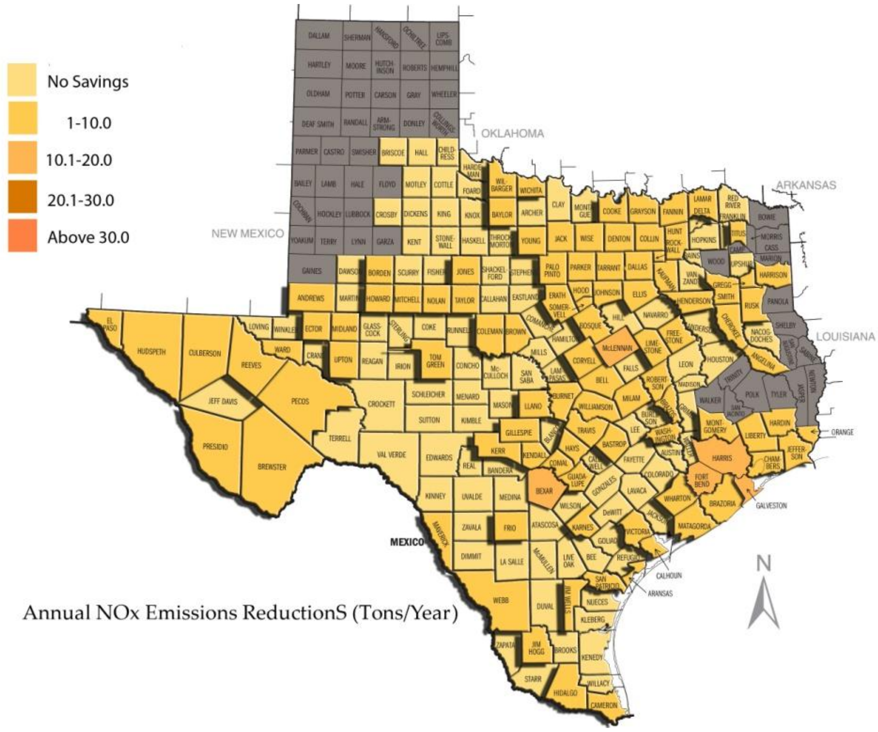


Figure 96: 2009 OSD NOx Reductions from Electricity and Natural Gas Savings Due to the IECC/IRC for Single-family and Multi-family Residences and for Commercial Buildings by County (using 2007 eGRID)



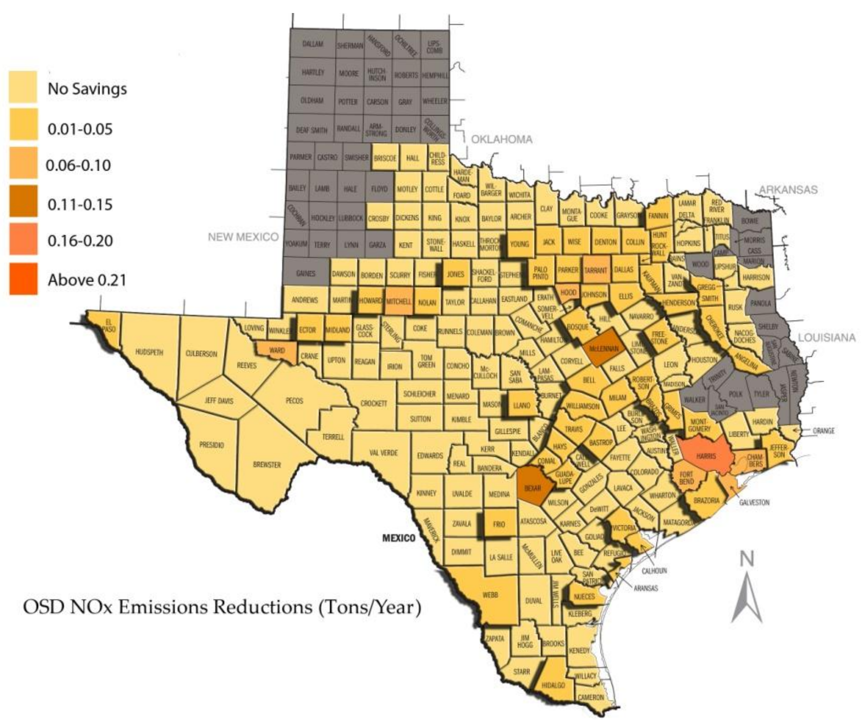
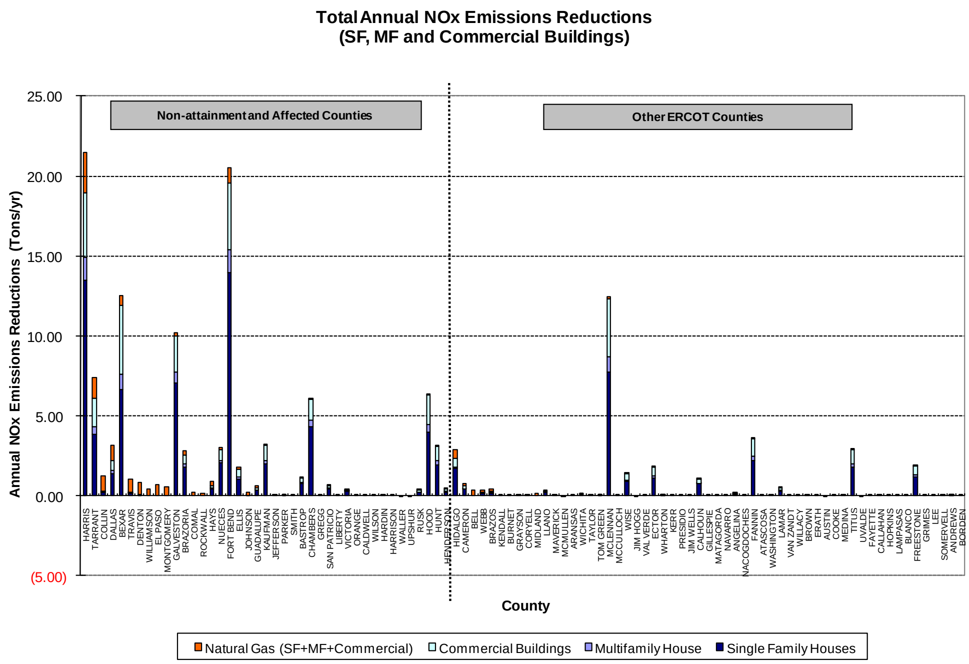


Figure 97: 2009 Annual and OSD NOx Reductions from Electricity and Natural Gas Savings Due to the IECC/IRC for Single-family and Multi-family Residences and for Commercial Buildings by County (using 2007 eGRID)

7 Comparison of 2009 Emissions Reductions vs 2008 Emissions Reductions

In this section a side-by-side comparison is presented of the 2009 emissions reductions calculations versus the 2008 emissions reductions for both the annual and Ozone Season Day (OSD). In Figure 98 and Figure 99 the annual and OSD NOx reductions are presented for the 2008 analysis, respectively. These can be compared to the values presented in Figure 100 and Figure 101 for the 2009 analysis.



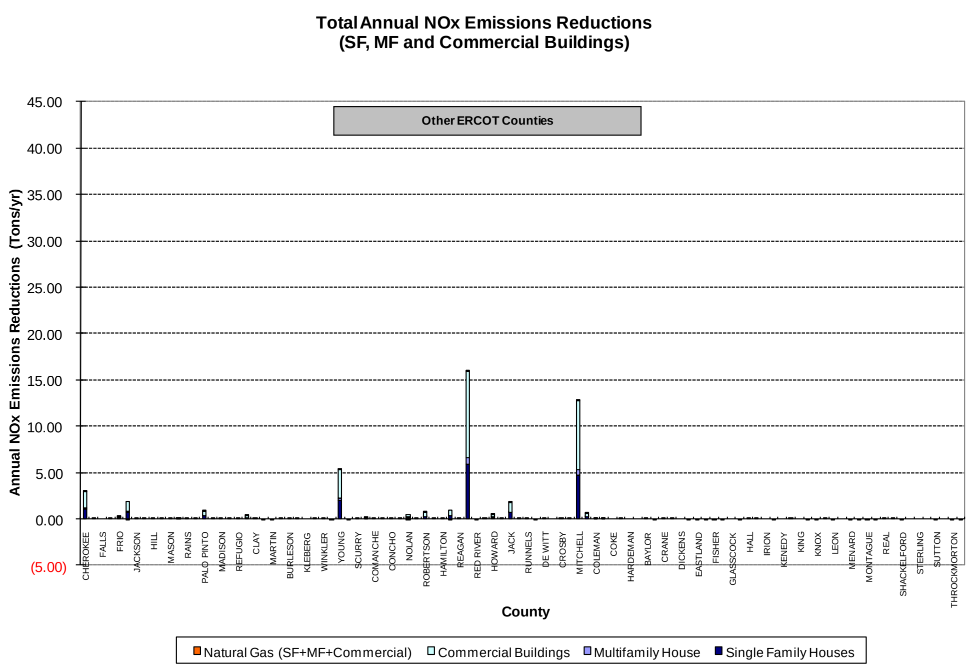
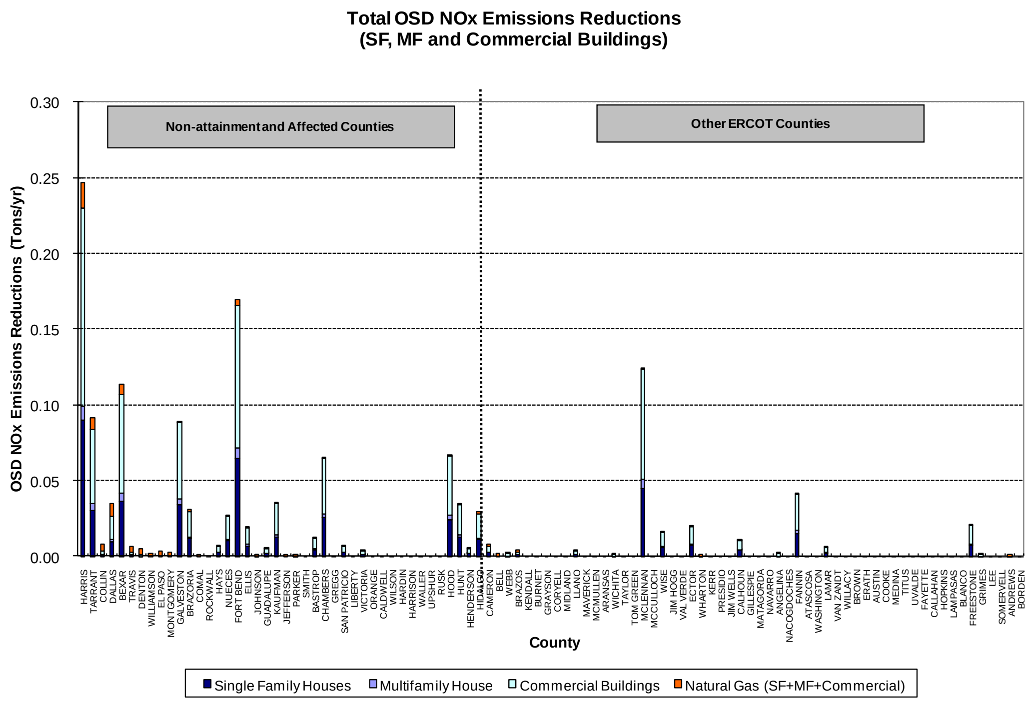


Figure 98: 2008 Annual NOx Reductions from Electricity and Natural Gas Savings Due to the IECC/IRC for Single-family, Multi-family Residences, and Commercial Buildings by County (using 2007 eGRID)



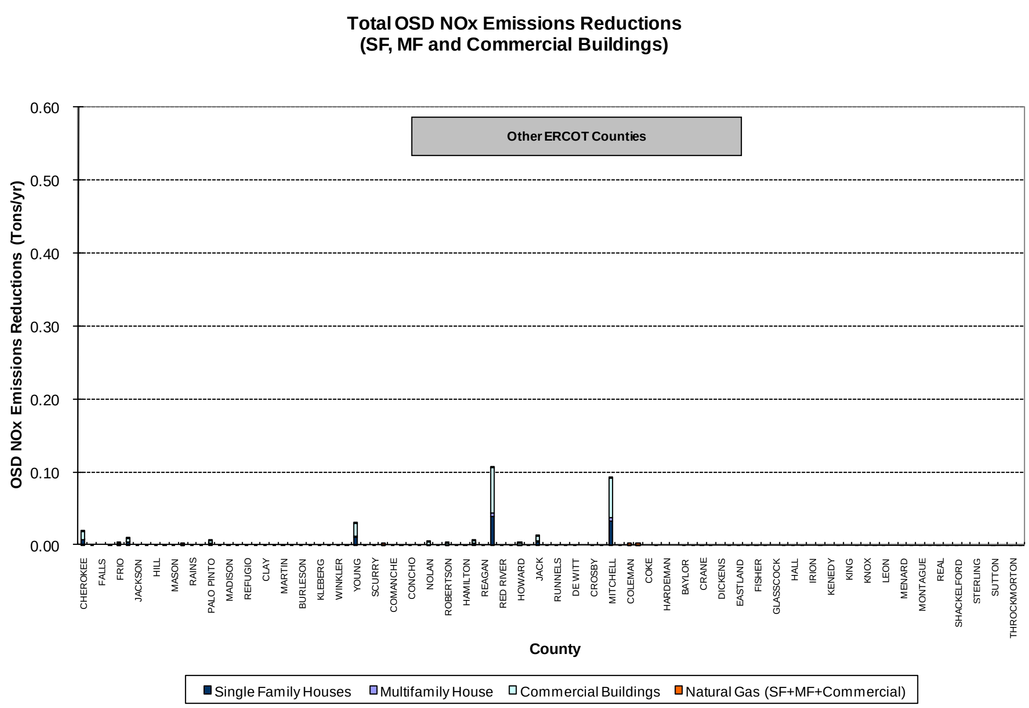
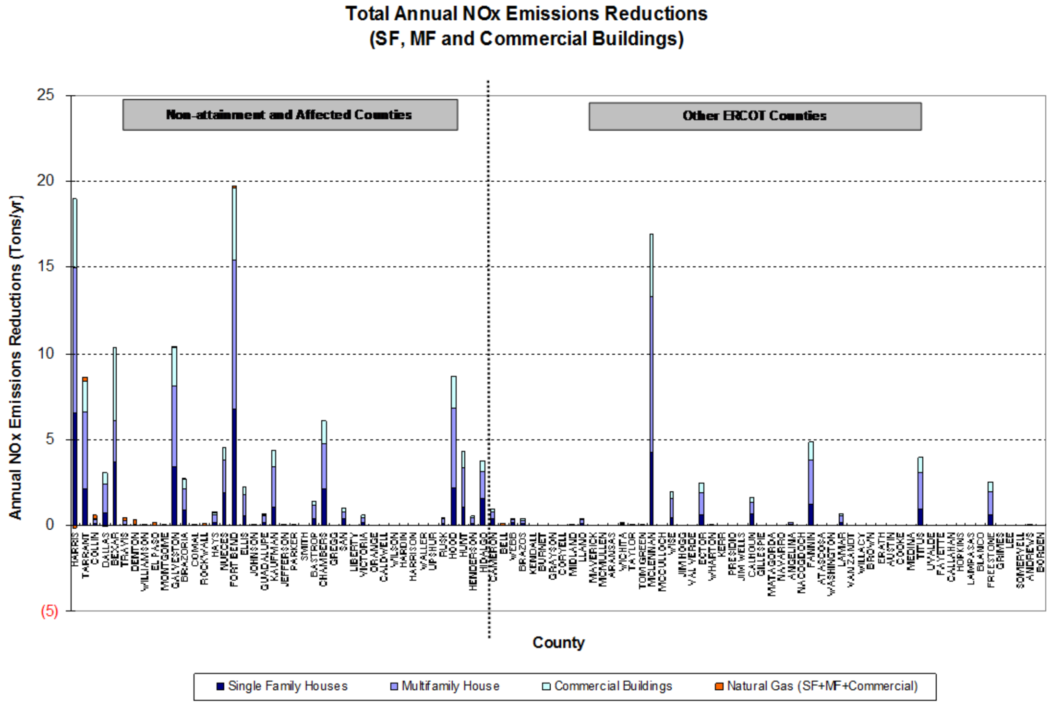


Figure 99: 2008 OSD NOx Reductions from Electricity and Natural Gas Savings Due to the IECC/IRC for Single-family, Multi-family Residences, and Commercial Buildings by County (Using 2007 eGRID)



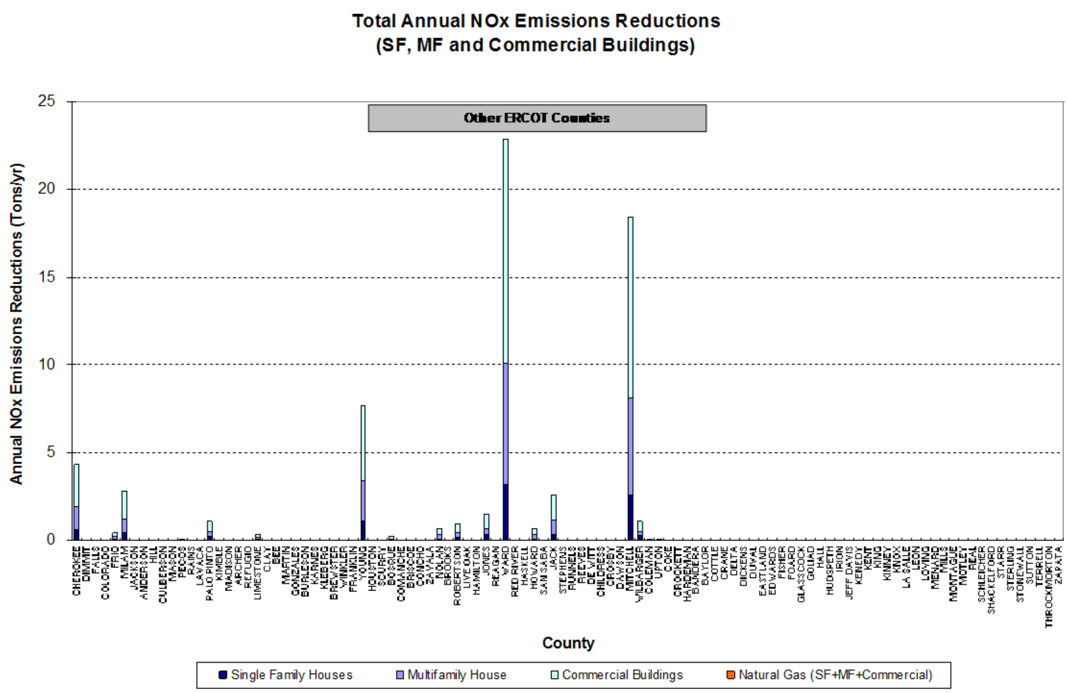
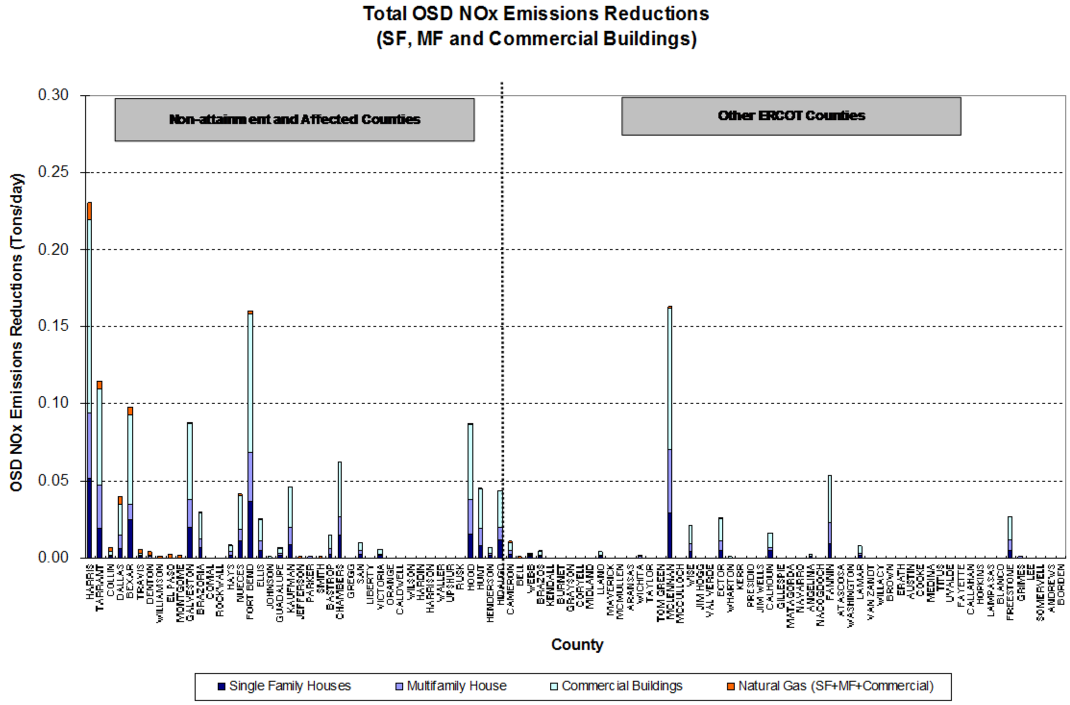


Figure 100: 2009 Annual NOx Reductions from Electricity and Natural Gas Savings Due to the IECC/IRC for Single-family and Multi-family Residences and for Commercial Buildings by County (using 1999 eGRID)



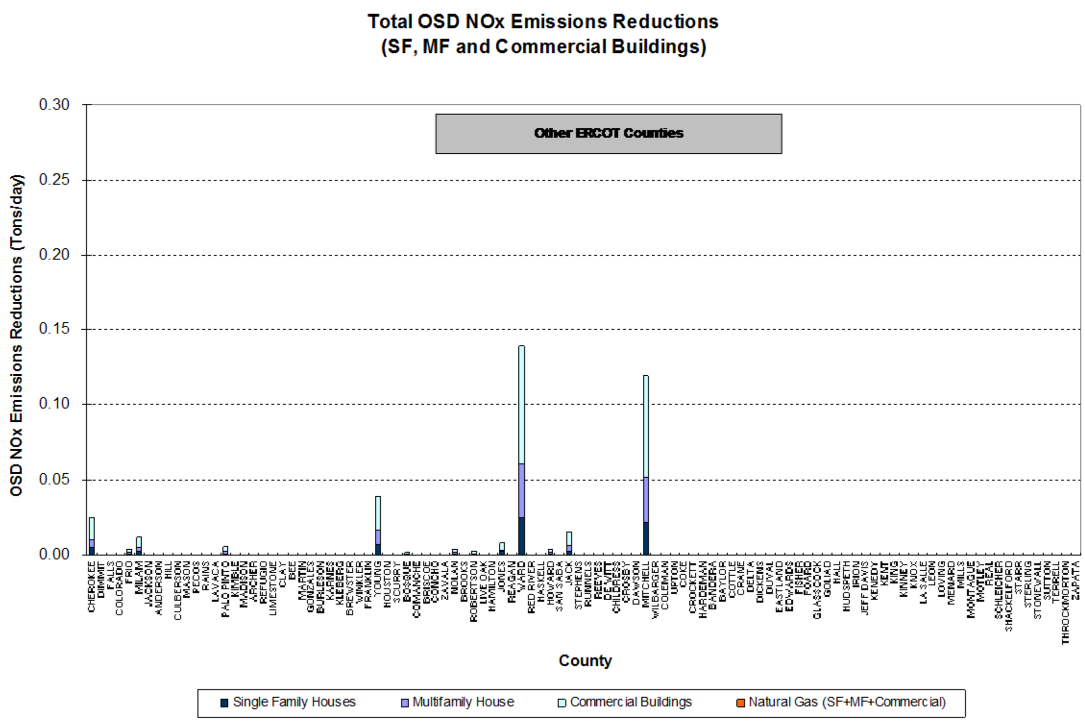


Figure 101: 2009 OSD NOx Reductions from Electricity and Natural Gas Savings Due to the IECC/IRC for Single-family and Multi-family Residences and for Commercial Buildings by County (using 2007 eGRID)

8 Calculation of Integrated NOx Emissions Reductions from Multiple State Agencies Participating in the Texas Emissions Reduction Plan (TERP)

8.1 Background

In January 2005, the Laboratory was asked by the Texas Commission on Environmental Quality (TCEQ) to develop a method by which the NOx emissions savings from the energy-efficiency programs from multiple Texas State Agencies working under Senate Bill 5 and Senate Bill 7 could be reported in a uniform format to allow the TCEQ to consider the combined savings for Texas' State Implementation Plan (SIP) planning purposes. This required that the analysis should include the cumulative savings estimates from all projects projected through 2020 for both the annual and Ozone Season Day (OSD) NOx reductions. The NOx emissions reduction from all these programs were calculated using estimated emissions factors for 2007 from the US Environmental Protection Agency (US EPA) eGRID database, which had been specially prepared for this purpose. The different programs included in the 2006 cumulative analysis are:

- ESL Single-family new construction
- ESL Multi-family new construction
- ESL Commercial new construction
- Federal Buildings
- Furnace Pilot Light Program
- PUC Senate Bill 7 and Senate Bill 5 Program
- SECO Senate Bill 5 Program
- Electricity generated by wind farms in Texas (ERCOT)[39]
- SEER13 upgrades to Single-family and Multi-family residences

The Laboratory's single-family and multi-family programs include the energy savings attained by constructing new residences in Texas according to the IECC 2000/2001 building code (IECC 2000). The baseline for comparison for the code programs is the published data on residential construction characteristics by the National Association of Home Builders (NAHB) for 1999 (NAHB 1999). Annual electricity (MWh) and natural gas (MMBtu) savings are from the Laboratory's Annual Reports to the TCEQ (Haberl et al., 2002 - 2007).

The Texas Public Utility Commission's (PUC) Senate Bill and Senate Bill 7 programs include their incentive and rebates programs managed by the different Utilities for Texas (PUC 2007). These include the Residential Energy Efficiency Programs (REEP) as well as the Commercial & Industrial Standard Offer Programs (C&I SOP). The energy efficiency measures include high efficiency HVAC equipment, variable speed drives, increased insulation levels, infiltration reduction, duct sealing, Energy Star Homes, etc. Annual electricity savings according to the utilities (or Power Control Authorities – PCAs) were reported for the different programs completed in the years 2001 through 2009. The PUC also reported the savings from the Senate Bill 5 grant program which was conducted in 2002 and 2003.

The Texas State Energy Conservation Office (SECO) funds energy-efficiency programs are directed towards school districts, government agencies, city and county governments, private industries and residential energy consumers. For the 2009 reporting year SECO submitted annual energy savings values for 149 projects, which included projects funded by SECO and by Energy Service projects.

The *Electric Reliability Council of Texas (ERCOT) electricity production from currently installed green power generation (wind)* in Texas is reported. Projections through 2013 include planned projects by ERCOT and annual growth factors beyond 2013 comply with the Legislative requirements. Actual measured electricity production for 2001 through 2009, were included.

Finally, NOx emissions reductions from several other programs are also reported, including: *energy efficiency measures applied to Federal buildings in Texas, reductions from the elimination of pilot lights in*

[39] ERCOT is the Electric Reliability Council of Texas.

residential furnaces, and reductions from the installation of SEER 13 air conditioners in existing residences.

8.2 Description of the Analysis Method

Annual and Ozone Season Day (OSD) NOx emissions reduction were calculated for 2009 and cumulatively from 2006 to 2020 using several factors to discount the potential savings. These factors include an annual degradation factor, a transmission and distribution factor, a discount factor and growth factors as shown in Table 57, and are described as follows:

Annual degradation factor: This factor was used to account for an assumed decrease in the performance of the measures installed as the equipment wears down and degrades. With the exception of electricity generated from wind, an annual degradation factor of 5% was used for all the programs[40]. This value was taken from a study by Kats et al. (1996).

Transmission and distribution loss: This factor adjusts the reported savings to account for the loss in energy resulting from the transmission and distribution of the power from the electricity producers to the electricity consumers. For this calculation, the energy savings reported at the consumer level are increased by 7% to give credit for the actual power produced that is lost in the transmission and distribution system on its way to the customer. In the case of electricity generated by wind, the T&D losses were assumed to cancel out since wind energy is displacing power produced by conventional power plants; therefore, there is no net increase or decrease in T&D losses.

Initial discount factor: This factor was used to discount the reported savings for any inaccuracies in the assumptions and methods employed in the calculation procedures. For the Laboratory's single- and multi-family program, the discount factor was assumed to be 20%. For PUC's Senate Bill 5 and Senate Bill 7 programs and electricity from wind, the discount factor was taken as 25%. For the savings in the SECO program, the discount factor was 60%.

Growth factor: The growth factors shown in Table 57 were used to account for several different factors. Growth factors for single-family (3.25%) and multi-family residential (1.54%) construction are projections based on the average growth rate for these housing types from recent U.S. Census data for Texas. Growth factors for wind energy are from the Texas Public Utilities Commission[41]. No growth was assumed for Federal buildings, pilot lights, PUC programs and SECO entries.

Figure 102 shows the overall information flow that was used to calculate the NOx emissions savings from the annual and Ozone Season Day (OSD) electricity savings (MWh) from all programs. For the Laboratory's single-family and multi-family code-implementation programs, the annual and ozone season savings were calculated from DOE-2 hourly simulation models[42]. The base case is taken as the average characteristics of single- and multi-family residences for Texas published by the National Association of Home Builders for 1999 (NAHB 1999). The OSD consumption is the average daily consumption for the period between July 15 and September 15, 1999. The annual electricity savings from PUC programs were calculated using deemed savings tables and spreadsheets created for the utilities incentive programs by Frontier Associates in Austin, Texas (PUC 2007).

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[40] A degradation of 5% per year would accumulate as a 5%, 10%, 15%...etc, degradation in performance. Although the assumption of this high level of degradation may not actually occur, it was chosen as a conservative estimate. For wind energy, a degradation factor of 0% was used. The choice of a 0% degradation factor for wind is based on two year's of analysis of measured wind data from all Texas wind farms that shows no degradation, on average, for a two year period after the wind farms became operational.

[41] The growth factors for wind energy through 2012 are based on permitted wind farms registered with the Texas Public Utilities Commission, http://www.puc.state.tx.us/electric/maps/gen_tables.xls. Growth factors for 2013 through 2020 assume a linear projection based on the permits for 2011 and 2012.

[42] These values are based on a performance analysis as defined by Chapter 4 of IECC 2000/2001. This analysis is discussed in the Laboratory's annual reports to the TCEQ.

The SECO electricity savings were submitted as annual savings by project[43]. A description of the measures completed for the project was also submitted for information purposes. The electricity production from wind farms in Texas was from the actual on-site metered data measured at 15-minute intervals.

Integration of the savings from the different programs into a uniform format allowed for creditable NOx emissions to be evaluated using different criteria as shown in Table 60. These include evaluation across programs, evaluation across individual counties by program, evaluation by SIP area, evaluation for all ERCOT counties except Houston/Galveston, and evaluation within a 200 km radius of Dallas/Ft.Worth.

8.3 Calculation Procedure

ESL Single-family and Multi-family. The calculation of the annual and OSD electricity savings reported for the years 2002 through 2009 included the savings from code-compliant new housing in all 41 non-attainment and affected counties as reported in the Laboratory's annual report submitted by the Laboratory to the Texas Commission of Environmental Quality (TCEQ). The savings for 2001 were also incorporated, since some of the programs were reporting savings from September to December 2001. From 2005 to 2009, the annual and OSD electricity savings were calculated for new residential construction in all the counties in ERCOT region, which includes the 41 non-attainment and affected counties. These savings were then tabulated by county and program. Using the calculated values through 2009, savings were then projected to 2020 by incorporating the different adjustment factors mentioned above.

In these calculations, it was assumed that the same amount of electricity savings from the code-complaint construction would be achieved for each year after 2009 through 2020[44]. The projected energy savings through 2020, according to county, were then divided into the different Power Control Authorities (PCA) in eGRID. To determine which PCA was to be used, or in counties with multiple PCA, the allocation to each PCA by county was obtained from PUC's listing published in the Laboratory's 2005 annual report[45].

For the 2009 annual and OSD NOx emissions calculations, the US EPA's 2007 eGRID were used[46]. An example of the eGRID spreadsheet[47] is given in Table 58. The total electricity savings for each PCA were used to calculate the NOx emissions reduction for each of the different counties using the emissions factors contained in eGRID. Similar calculations were performed for each year for which the analysis was required. The cumulative NOx emissions reduction for the electricity savings from residential new construction for 2006 through 2020 is provided in Figure 103 and Figure 104.

ESL-Commercial Buildings. The annual and OSD electricity savings for 2002 through 2009 for commercial buildings were obtained from the annual reports for 2005 and 2008 submitted by the Laboratory to TCEQ[48]. These savings were also tabulated by county and program. Using the calculated values through 2009, savings were then projected to 2020 by incorporating the different adjustment factors mentioned above[49]. In the projected 2009 cumulative electricity savings, it was assumed that the same amount of electricity savings from 2009 would be achieved for each year after 2009 through 2020. Similarly to the single family

[43] The reporting requirements to the SECO did not require energy savings by project type, although for selected sites, energy savings by project type was available. Annual savings were reported by SECO in 2004. Values for 2005 to 2007 use the adjusted values from 2004 as shown, www.seco.cpa.state.tx.us.
[44] This would include the appropriate discount and degradation factors for each year.
[45] Haberl et al., 2005, pp. 197.
[46] This required two separate versions of the 2007 eGRID, which were specially prepared for Texas by Mr. Art Diem at the US EPA. One of the versions contains estimates of annual SOx, NOx and CO2 data for 2007, using a 25% capacity factor. The second version contains estimates of SOx, NOx and CO2 data for 2007 for an average day in the ozone season period, which runs from Mid July to Mid September.
[47] To use this spreadsheet electricity savings for each PCA is entered in the bottom row of the spreadsheet (MWh). The spreadsheet then allocates the MWh of electricity savings according to the counties (blue columns) where the PCA owned and operated a power plant. Totals for all PCAs are then listed on the far right columns (white columns). Similar spreadsheets for the 2007 eGRID exist for SOx and CO2.
[48] These savings include new construction in office, assembly, education, retail, food, lodging and warehouse construction as defined by Dodge building type (Dodge 2005), using energy savings from the Pacific Northwest National Laboratory (USDOE 2004), and data from CBECS (1995 - 2003).
[49] This also includes the appropriate discount and degradation factors for each year.

calculations, the projected energy saving numbers through 2020, by county, were allocated into the appropriate Power Control Authorities (PCA).

Federal Buildings. Energy savings achieved from Energy Savings Performance Contracts (ESPCs) were also reported in 2009. This includes savings (estimated) from energy conservation measures implemented in Federal Buildings in Texas. The 2009 savings include projects implemented in 14 Federal buildings reported by the regional office of the Department of Energy. Annual kWh savings reported for each of the projects were divided by 365 to obtain the average Ozone Season Day savings[50]. In the calculation for 2009, it was assumed that the electricity savings from 2006 would also be achieved for each year from 2009 through 2020 after the appropriate degradation factors were applied. Similarly to the single family calculations, the projected energy saving numbers through 2020, by county, were proportioned into the PUC's Power Control Authorities (PCA) and the cumulative NOx emission reduction values calculated.

Furnace Pilot Light Program. For the furnace pilot light program savings, the natural gas energy savings achieved by retrofitting existing furnaces in single-family and multi-family residences for the entire residential stock for Texas have been projected until 2020. Pilot light removal saves an estimated 500 Btu/hr of natural gas for each hour of operation for the entire life of the furnace when the furnace is replaced with a code-compliant replacement. The energy savings for the Ozone Season Day are calculated by dividing the annual number by 365. It is also assumed that of the total furnaces that were retrofitted, 75% are operational during the Ozone Season Period. Cumulative NOx emissions reduction for the natural gas savings from the removal of furnace pilot lights were also calculated by county for 2006 through 2020 by SIP area[51].

PUC-Senate Bill 7. For the PUC Senate Bill 7 program savings, the annual electricity savings for 2001 through 2009 were obtained from the Public Utilities Commission [52]. Using these values, savings were projected through 2020 by incorporating the different adjustment factors mentioned above. Similar savings were assumed for each year after 2009 until 2020. The 2009 annual and OSD eGRID was also used to calculate the NOx emissions savings for the PUC-Senate Bill 7 program. The total electricity savings for each PCA was used to calculate the NOx emissions reduction for each county using the emissions factors contained in the US EPA's eGRID spreadsheet. The cumulative NOx emissions reduction for each county, by SIP area, for the different programs was then calculated.

PUC-TERP Grants Program. To calculate the annual electricity savings from the PUC's TERP program, electricity savings were also obtained from the Public Utilities Commission[53]. The annual and average day electricity savings were then proportioned according to the PCA and program. Using the actual reported numbers through 2009, savings through 2020 were projected incorporating the different adjustment factors mentioned above[54]. The 2009 annual and OSD eGRID were used to calculate the NOx emissions savings for PUC-TERP Grants Program. The total electricity savings for each PCA were used to calculate the NOx emissions reduction for each of the different counties.

SECO Savings. The annual electricity savings from energy conservation projects reported by political subdivisions for 35 counties through 2009 were obtained from the State Energy Conservation Office[55].

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[50] This method yields suitable OSD values for lighting retrofits and/or retrofits that are not weather dependent. In the case of retrofits to cooling systems, weather normalization would increase the OSD savings substantially. Retrofits to heating systems would be reduced by weather normalization.

[51] These use the NOx/MBtu values provided in the US EPA AP 42 guideline.

[52] In a similar fashion to the previous programs, to obtain the Ozone Season Day (OSD) savings, the annual electricity savings were divided by 365.

[53] In a similar fashion as the PUC's Senate Bill 7 program, the annual electricity savings numbers were then divided by 365 to get average electricity savings per day for OSD calculations. The preferred approach would be to weather-normalize the savings and then calculate savings for the OSD period. However, only annual values were obtained for the 2005 report to the TCEQ. Dividing the annual values by 365 is probably a reasonable approach for lighting projects. However, this undercounts potential savings from electric loads associated with the cooling season.

[54] Since the savings for the PUC's Senate Bill 5 were only reported for two years these savings actually reduced due to the imposed degradation factor.

[55] In a similar fashion as the PUC's Senate Bill 5 and 7 programs, these annual electricity savings numbers were divided by 365 to get average electricity savings per day for the OSD calculations.

These submittals included information gathered from SECO's website[56] and paper submittals[57]. The annual and average day electricity values where then summarized according to county and program. Using the actual reported numbers for 2004, savings through 2020 were projected using the different adjustment factors mentioned above. In a similar fashion as the previous programs, it was assumed that the same amount of electricity savings will be achieved for each year after 2005 until 2020. The 2009 annual and OSD eGRID were then used to calculate the NOx emissions savings for the SECO program.

Electricity Generated by Wind Farms. The measured electricity production from all the wind farms in Texas for 2001 through 2009 was obtained from the Energy Reliability Council of Texas (ERCOT). To obtain the annual production, the 15-minute data were summed for the 12 months, while for the OSD period the data were converted to average daily electricity production during the months of July, August and September. Using the reported numbers for 2009, savings through 2020 were projected incorporating the different adjustment factors mentioned above. The 2009 annual and OSD eGRID were then used to calculate the NOx emissions reduction for the electricity generated by Texas' wind farms[58]. The total electricity savings for each PCA were used to calculate the NOx emissions reduction for each of the different counties.

SEER 13 Single-Family and Multi-family. In January of 2006, Federal Regulations mandated that the minimum efficiency for residential air conditioners be increased to SEER 13 from the previous SEER 10. Although the electricity savings from new construction reflected this change in values, the annual and OSD electricity savings from the replacement of the air conditioning units by air conditioners with an efficiency of SEER 13 in existing residences needed to be calculated.

In the 2009 report to the TCEQ, the annual and OSD electricity savings for all the counties in ERCOT region as well as the 41 non-attainment and affected counties was calculated for the retrofit. Using the numbers for 2009, the savings through 2020 were projected by incorporating the appropriate adjustment factors[59]. In this analysis it was assumed that an equal number of existing houses had their air conditioners replaced, as reported for 2008, by the air conditioner manufacturers. This replacement rate continued until all the existing air conditioner stock was replaced with SEER 13 air conditioners. The total electricity savings for each PCA were used to calculate the NOx emissions reduction for each of the different county using the emissions factors contained in the 2007 eGRID. Cumulative NOx emissions reduction for each county by SIP area was also calculated.

8.4 Results

The total cumulative annual and OSD electricity savings for all the different programs in the integrated format was calculated for 2005 through 2020, as shown in Table 59, using the adjustment factors shown in Table 57. NOx emissions reduction from the electricity and natural gas savings for the annual and OSD for all the programs in the integrated format is shown in Table 60. In Table 59and Table 60 annual values are shown for 2005, and cumulative annual values are shown 2006 through 2020. The OSD NOx emissions reduction is also shown in Figure 103 as stacked bar charts and in Figure 104 for the individual components.

In 2009, the cumulative annual electricity savings[60] from code-compliant residential and commercial construction is calculated to be 1,688,687 MWh/year (6.6% of the total electricity savings), savings from retrofits to Federal buildings is 251,708 MWh/year (1.0%), savings from furnace pilot light retrofits is 2,548,904 MMBtu/year (2.9%), which is equivalent to 746,822 MWh/year, savings from the PUC's Senate Bill 5 and Senate Bill 7 programs is 2,347,661 MWh/year (9.2%), savings from SECO's Senate Bill 5

[56] This web site was developed for SECO by the Laboratory, at the request of the TCEQ.
[57] In these submittals, there were several municipalities whose electricity or natural consumption increased in 2004 as compared to 2001, which caused the reported savings from these municipalities to be negative. Since no additional information was reported from these projects that might have indicated what the cause of this was, it was assumed that the energy conservation projects were working as designed, but that other factors had changed the energy consumption. Therefore, in the final values of electricity savings from the political subdivisions that reported to SECO for the calculation of annual and OSD NOx reductions, the negative savings were omitted.
[58] This credited the electricity generated by the wind farm to the utility that either owned the wind farm or was associated with the wind farm owner.
[59] Additional details about this calculation are contained in the Laboratory's 2006 Annual Report to the TCEQ, available at the Senate Bill 5 web site "eslsb5.tamu.edu".
[60] This includes the savings from 2001 through 2008.

program is 457,921 MWh/year (1.8%), electricity savings from green power purchases (wind) is 18,808,351 MWh/year (73.5%), and savings from residential air conditioner retrofits[61] is 1,283,931 MWh/year (5.0%). The total savings from all programs is 25,585,081 MWh/year.

In 2009, the cumulative OSD electricity savings from code-compliant residential and commercial construction is calculated to be 9,510 MWh/day (14.3%), savings from retrofits to Federal buildings is 690 MWh/day (1.0%), savings from furnace pilot light retrofits is 6,983 MMBtu/day (3.1%), which is equivalent to 2,046 MWh/day, savings from the PUC's Senate Bill 5 and Senate Bill 7 programs is 6,432 MWh/day (9.7%), savings from SECO's Senate Bill 5 program is 1,255 MWh/day (1.9%), electricity savings from green power purchases (wind) are 37,261 MWh/day (56.2%), and savings from residential air conditioner retrofits are 9,106 MWh/day (13.7%). The total savings from all programs is 66,300 MWh/day (64,254 MWh/day and 6,983 MMBtu/day), which would be a 2,763 MW average hourly load reduction during the OSD period.

By 2013, the cumulative annual electricity savings from code-compliant residential and commercial construction is calculated to be 2,176,034 MWh/year (6.8% of the total electricity savings), savings from retrofits to Federal buildings will be 402,732 MWh/year (1.3%), savings from furnace pilot light retrofits will remain at 2,548,904 MMBtu/year (2.3%), which is equivalent to 746,822 MWh/year, savings from the PUC's Senate Bill 5 and Senate Bill 7 programs will be 3,451,975 MWh/year (10.8%), savings from SECO's Senate Bill 5 program will be 489,440 MWh/year (1.5%), electricity savings from green power purchases (wind) will be 22,426,692 MWh/year (70.1%), and savings from residential air conditioner retrofits[62] will be 2,286,233 MWh/year (7.1%). The total savings from all programs will be 31,979,928 MWh/year.

By 2013, the cumulative OSD electricity savings from code-compliant residential and commercial construction is calculated to be 12,566 MWh/day (14.4%), savings from retrofits to Federal buildings will be 1,103 MWh/day (1.3%), savings from furnace pilot light retrofits will remain at 6,983 MMBtu/day (2.3%), which is equivalent to 2,046 MWh/day, savings from the PUC's Senate Bill 5 and Senate Bill 7 programs will be 9,458 MWh/day (10.9%), savings from SECO's Senate Bill 5 program will be 1,341 MWh/day (1.5%), electricity savings from green power purchases (wind) will be 44,429 MWh/day (51.0%), and savings from residential air conditioner retrofits will be 16,216 MWh/day (18.6%). The total savings from all programs will be 87,159 MWh/day (85,113 MWh/day and 6,983 MMBtu/day), which would be a 3,632 MW average hourly load reduction during the OSD period.

In 2009, the cumulative annual NOx emissions reduction[63] from code-compliant residential and commercial construction is calculated to be 1,090 tons-NOx/year (7.8% of the total NOx savings), savings from retrofits to Federal buildings is 193 tons-NOx/year (1.3%), savings from furnace pilot light retrofits is 117 tons-NOx/year (0.8%), savings from the PUC's Senate Bill 5 and Senate Bill 7 programs is 1,638 tons-NOx/year (10.7%), savings from SECO's Senate Bill 5 program is 349 tons-NOx/year (2.3%), electricity savings from green power purchases (wind) is 10,957 tons-NOx/year (71.5%), and savings from residential air conditioner retrofits is 884 tons-NOx/year (5.8%). The total NOx emissions reduction from all programs is 15,328 tons-NOx/year.

In 2009, the cumulative OSD NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 6.56 tons-NOx/day (16.1%), savings from retrofits to Federal buildings is 0.51 tons-NOx/day (1.3%), savings from furnace pilot light retrofits is 0.32 tons-NOx/day (0.8%), savings from the PUC's Senate Bill 5 and Senate Bill 7 programs is 4.39 tons-NOx/day (10.8%) , savings from SECO's Senate Bill 5 program is 0.95 tons-NOx/day (2.3%), electricity savings from green power purchases (wind) are 21.79 tons-NOx/day (53.5%), and savings from residential air conditioner retrofits are 6.19 tons-NOx/day (15.2%). The total NOx emissions reduction from all programs is 40.71 tons-NOx/day.

[61] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.
[62] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.
[63] These NOx emissions reduction were calculated with the US EPA's 2007 eGRID for annual (25% capacity factor) and Ozone Season Day OSD.

By 2013, the cumulative annual NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 1,541 tons-NOx/year (8.0% of the total NOx savings), savings from retrofits to Federal buildings will be 308 tons-NOx/year (1.6%), savings from furnace pilot light retrofits will be 117 tons-NOx/year (0.6%), savings from the PUC's Senate Bill 5 and Senate Bill 7 programs will be 2,355 tons-NOx/year (12.1%), savings from SECO's Senate Bill 5 program will be 373 tons-NOx/year (1.9%), electricity savings from green power purchases (wind) will be 13,065 tons-NOx/year (67.6%), and savings from residential air conditioner retrofits will be 1,574 tons-NOx/year (8.1%). The total NOx emissions reduction from all programs will be 19,313 tons-NOx/year.

By 2013, the cumulative OSD NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 8.72 tons-NOx/day (16.1%), savings from retrofits to Federal buildings will be 0.81 tons-NOx/day (1.5%), savings from furnace pilot light retrofits will be 0.32 tons-NOx/day (0.6%), savings from the PUC's Senate Bill 5 and Senate Bill 7 programs will be 6.28 tons-NOx/day (11.6%), savings from SECO's Senate Bill 5 program will be 1.01 tons-NOx/day (1.9%), electricity savings from green power purchases (wind) will be 25.99 tons-NOx/day (48.0%), and savings from residential air conditioner retrofits will be 11.03 tons-NOx/day (20.4%). The total NOx emissions reduction from all programs will be 54.16 tons-NOx/day.

Table 57: Final Adjustment Factors used for the Calculation of the Annual and OSD NOx Savings for the Different Programs

	ESL-Single Family[16]	ESL-Multifamily[16]	ESL-Commercial[16]	Federal Buildings[15]	Furnace Pilot Light Program[15]	PUC (SB7)[15]	PUC (SB5 Grant Program)[15]	SECO[15]	Wind-ERCOT[8]	SEER13 Single Family	SEER13 Multifamily
Annual Degradation Factor [11]	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	0.00%	5.00%	5.00%
T&D Loss [9]	7.00%	7.00%	7.00%	7.00%	0.00%	7.00%	7.00%	7.00%	0.00%	7.00%	7.00%
Initial Discount Factor [12]	20.00%	20.00%	20.00%	20.00%	20.00%	25.00%	25.00%	60.00%	25.00%	20.00%	20.00%
Growth Factor	3.25%	1.54%	3.25%	0.00%	0.00%	0.00%	0.00%	0.00%	Actual Rates	N.A.	N.A.
Weather Normalized	Yes	Yes	Yes	No	No	No	No	No	See note 7	Yes	Yes

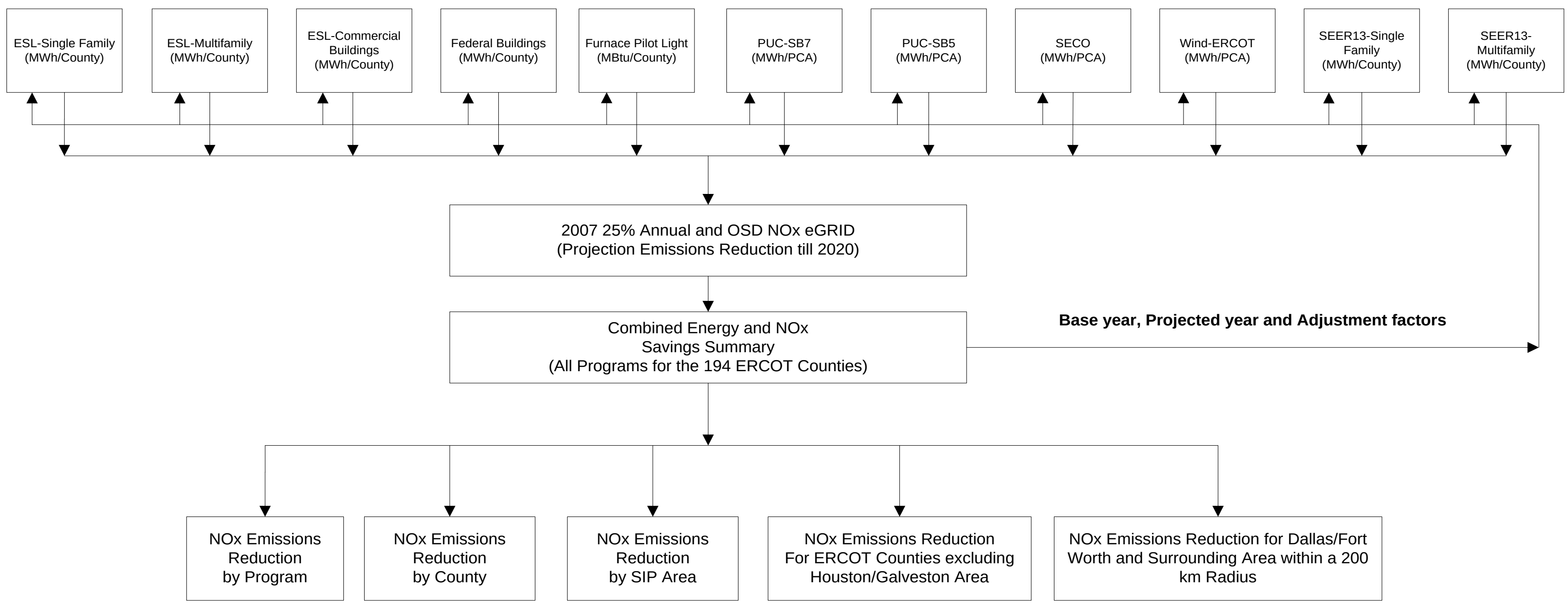

Figure 102: Process Flow Diagram of the NOx Emissions Reduction Calculations

Table 58: Example of NOx Emissions Reduction Calculations using eGRID

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs)	Lower Colorado River Auhotrity /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/PCA	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.008831132	226.0465792	0.010890729	8.193488679	0.006522185	0	0.003944232	14.32402746	0.065444292	3035.079423	0.014877434	272.3666894	0.006262315	0	0.004817148	0	0.121274957	139.7235344	0.00816387	940.7285451	4636.462287	2.318231144
	Chambers	0.021762222	557.0379581	0.026955801	20.27982242	0.016072371	0	0.009076193	32.96145962	0.164940225	7649.355979	0.037472294	686.0191605	0.015055623	0	0.009553214	0	0.011518588	13.2708178	0.015818592	1822.787617	10781.71281	5.390856407
	Fort Bend	0.070431234	1802.797078	0.087239726	65.63359654	0.052016606	0	0.029374182	106.6764342	0.533812376	24756.36787	0.121275295	2220.231709	0.048726002	0	0.030918012	0	0.037278747	42.94966114	0.051195276	5899.267979	34893.92432	17.44696216
	Galveston	0.033856739	866.6159501	0.041710519	31.3803294	0.025004711	0	0.015351589	55.75143316	0.249587379	11574.99759	0.056747051	1038.889275	0.024143087	0	0.019297151	0	0.567751219	654.118618	0.032836887	3783.817742	18005.57093	9.002785467
	Harris	0.068267332	1747.408655	0.084559408	63.61709594	0.050418468	0	0.028471701	103.3989497	0.517411736	23995.76304	0.117549281	2152.01819	0.047228963	0	0.029968099	0	0.03613341	41.63009278	0.049622373	5718.021208	33821.85723	16.91092861
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.002039135	52.19483875	0.003716345	2.795940278	0.001505992	0	0.005950953	21.61171382	0.002481478	115.0823578	0.000717051	13.12731328	0.019166247	0	0.07668094	0	0.00086441	0.995905867	0.004000199	460.945804	666.7538738	0.333376937
	Dallas	0.004539471	116.1948312	0.004683963	3.523914222	0.003352602	0	0.00774211	28.1165509	0.002085611	96.72341896	0.00068106	12.46842352	0.007502816	0	0.026717045	0	0.007524933	8.669640256	0.040370454	4651.916039	4917.612818	2.458806409
	Denton	0.00047388	12.12970385	0.000872802	0.656640103	0.000349982	0	0.001396994	5.073377767	0.000585443	27.15083393	0.000168971	3.093405773	0.00454374	0	0.018187155	0	0.000186605	0.214992277	0.000849405	97.87758499	146.1965387	0.073098269
	Tarrant	0.012162492	311.3179263	0.012266309	9.228387517	0.008982543	0	0.020308652	73.75369976	0.005316504	246.5610524	0.001752506	32.08377752	0.017326428	0	0.060216761	0	0.020603444	23.73767965	0.110647237	12749.95959	13446.64211	6.723321056
	Ellis	0.003279814	83.95193355	0.003307809	2.488584531	0.002422289	0	0.005476558	19.88888265	0.001433682	66.48919108	0.000472592	8.651911537	0.004672353	0	0.016238427	0	0.005556053	6.401250735	0.029837824	3438.233618	3626.105373	1.813052686
	Johnson	0.000286058	7.322112154	0.000526868	0.396381687	0.000211267	0	0.000843297	3.062551359	0.000353404	16.38963767	0.000101999	1.867338584	0.002742835	0	0.010978701	0	0.000112645	0.129780379	0.000512745	59.08393672	88.25173856	0.044125869
	Kaufman	0.006325453	161.9098051	0.006379446	4.799487271	0.004671629	0	0.010562096	38.3577242	0.002765	128.2311379	0.000911441	16.68608752	0.009011105	0	0.031317452	0	0.010715411	12.34546025	0.057545265	6630.9817	6993.311403	3.496655701
	Parker	0.000217489	5.566981877	0.000400576	0.301367914	0.000160626	0	0.000641157	2.328449436	0.000268692	12.46099677	7.75498E-05	1.419732426	0.00208537	0	0.008347076	0	8.56434E-05	0.098671668	0.000389838	44.92135575	67.09755584	0.033548778
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.000819895	20.98648722	0.000826893	0.622101782	0.000605529	0	0.001369042	4.971866208	0.000358395	16.62111282	0.00011814	2.162823693	0.001168005	0	0.004059317	0	0.001388914	1.600198603	0.007458924	859.4971295	906.4617199	0.45323086
	Hood	0.01252711	320.6508812	0.012634039	9.505044007	0.009251829	0	0.020917482	75.96475123	0.005475887	253.9526704	0.001805044	33.04561243	0.017845854	0	0.062021991	0	0.021221112	24.4493081	0.113964315	13132.18878	13849.75705	6.924878523
	Hunt	0.006187558	158.3801895	0.006240374	4.694858985	0.004569788	0	0.010331844	37.5215301	0.002704724	125.4357135	0.000891572	16.32233268	0.008814664	0	0.030634735	0	0.010481817	12.0763306	0.056290785	6486.427041	6840.857996	3.420428998
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.033413751	855.276978	0.051775843	38.95283667	0.024677545	0	0.090663423	329.2568536	0.001141841	52.95463998	1.143571754	20935.7914	0.046873844	0	0.004669544	0	0.000519582	0.598622181	0.002503865	288.5221599	22501.3535	11.25067675
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.002000467	51.20507169	0.076378745	57.46248772	0.001477434	0	0.133848731	486.0903138	0.001237133	57.37392999	0.003554796	65.07897116	0.001061766	0	0.001855699	0	0.000401718	0.462828487	0.001835165	211.4673431	929.140946	0.464570473
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.004502334	115.2442433	0.171901148	129.3274415	0.003325174	0	0.301245466	1094.014881	0.002784342	129.1281298	0.008000571	146.4694129	0.002389654	0	0.004176513	0	0.000904124	1.041660856	0.004130298	475.937112	2091.162881	1.04558144
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.002458599	62.93167289	0.093870431	70.62211537	0.001815785	0	0.164501762	597.4110691	0.001520452	70.51327681	0.004368889	79.98286869	0.001304924	0	0.002280677	0	0.000493717	0.568821994	0.00225544	259.8960069	1141.925832	0.570962916
	Travis	0.000510007	13.05442349	0.299602906	225.4020851	0.000376663	0	0.033939476	123.2559365	0.000334709	15.52263338	0.000906121	16.58869273	0.000271138	0	0.000471744	0	0.000103327	0.119045148	0.000467336	53.85143207	447.7942484	0.223897124
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0.000685965	17.55833805	0.00069182	0.520481264	0.000506616	0	0.001145408	4.159710327	0.000299851	13.90604891	9.88414E-05	1.809525774	0.000977211	0	0.003396227	0	0.001162035	1.338805667	0.006240507	719.0980079	758.3909179	0.379195459
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22756873	5824.975938	0.004556851	3.428283791	0.168069652	0	0.007612767	27.64682441	0.001680888	77.95375313	0.001626796	29.78235622	0.046792036	0	0.007246366	0	0.001609426	1.854254911	0.008283395	954.5014455	6920.142856	3.460071428
	San Patricio	0.050313351	1287.848557	0.001007478	0.757961986	0.037158653	0	0.001683113	6.112458369	0.000371629	17.2348572	0.00035967	6.584604794	0.010345288	0	0.001602105	0	0.000355829	0.409958691	0.001831382	211.0314828	1529.979881	0.76498994
Victoria Area	Victoria	0.021836736	558.9452467	0.002215582	1.666862472	0.016127403	0	0.003612695	13.12000619	0.001199621	55.63426979	0.000555389	10.16770824	0.52545648	0	0.032412721	0	0.000476855	0.549395481	0.002254849	259.8278678	899.9113567	0.449955678
Other ERCOT counties	Andrews	2.47421E-05	0.633312124	2.49533E-05	0.018773251	1.82731E-05	0	4.13138E-05	0.150036693	1.08153E-05	0.501577618	3.56511E-06	0.065267829	3.5247E-05	0	0.000122499	0	4.19135E-05	0.048289414	0.000225089	25.93716362	27.35442055	0.01367721
	Angelina	0.00031082	7.955919749	0.000313473	0.235837079	0.000229554	0	0.000519	1.884820844	0.000135867	6.301018286	4.47864E-05	0.81992053	0.000442787	0	0.001538876	0	0.000526534	0.606630902	0.002827658	325.8330045	343.6371519	0.171818576
	Bosque	0.000595392	15.23997933	0.001096604	0.825014503	0.000439723	0	0.001755208	6.374283599	0.000735562	34.11279889	0.000212298	3.88661097	0.005708837	0	0.02285067	0	0.000234455	0.270120186	0.001067208	122.9751683	183.6839758	0.091841988
	Brazos	0.001939725	49.65028649	0.003572622	2.687812467	0.001432574	0	0.005718288	20.7667609	0.002396384	111.1359931	0.000691644	12.66217912	0.018598805	0	0.074445136	0	0.000763829	0.880023807	0.003476855	400.6404605	598.4235164	0.299211758
	Calhoun	0.082699809	2116.830355	0.001655986	1.245858399	0.061077496	0	0.002766524	10.04701783	0.000610844	28.32885022	0.000591187	10.8230826	0.0170045	0	0.002633372	0	0.000584875	0.673847089	0.003010234	346.8714129	2514.820424	1.257410212
	Cameron	0.048371747	1238.150172	0.000968599	0.728712051	0.297964476	0	0.001618161	5.876577133	0.000357288	16.56975992	0.00034579	6.330503314	0.009946061	0	0.001540279	0	0.000342098	0.394138287	0.001760709	202.8877272	1470.93759	0.735468795
	Cherokee	0.003503899	89.68774747	0.003533808	2.658611083	0.002587786	0	0.00585073	21.24774271	0.001531635	71.03190513	0.00050488	9.243032581	0.00499158	0	0.017347879	0	0.005935657	6.838600793	0.031876422	3673.14266	3873.8503	1.93692515
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.001298787	33.24447222	2.6007E-05	0.019566001	0.000959212	0	4.34478E-05	0.157786761	9.59321E-06	0.444899929	9.2845E-06	0.16997473	0.000267053	0	4.13567E-05	0	9.18536E-06	0.010582658	4.72752E-05	5.447558433	39.49484073	0.01974742
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.003535748	90.50296541	0.003565928	2.682776563	0.002611307	0	0.005903911	21.44087434	0.001545556	71.67755054	0.00050947	9.327047245	0.005036951	0	0.017505563	0	0.00598961	6.900760344	0.032166163	3706.529738	3909.061712	1.954530856
	Fannin	0.007056315	180.6173605	0.007116546	5.354034748	0.005211403	0	0.011782473	42.78969328	0.003084477	143.0473568	0.001016752	18.61404924	0.010052276	0	0.034935966	0	0.011953503	13.77189259	0.064194222	7397.14566	7801.340048	3.900670024
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.003677178	94.12308402	0.003708565	2.790087625	0.00271576	0	0.006140067	22.29850932	0.001607379	74.54465257	0.000529848	9.700129134	0.005238429	0	0.018205785	0	0.006229194	7.176790757	0.033452809	3854.790927	4065.42418	2.03271209
	Frio	0.008588335	219.8317964	0.000871383	0.655572927	0.006342868	0	0.001420864	5.160066298	0.000471808	21.88082203	0.000218433	3.998934744	0.206660746	0	0.012747844	0	0.000187546	0.216075897	0.000886827	102.189664	353.9329323	0.176966466
	Grimes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.188527456	4825.653746	0.003775086	2.840133709	0.139235931	0	0.006306735	22.9037859	0.001392518	64.58015017	0.001347706	24.6729498	0.03876448	0	0.006003193	0	0.001333316	1.536142338	0.006862311	790.7489276	5732.935836	2.866467918
	Howard	0.000555113	14.20898268	0.000559851	0.421196428	0.000409976	0	0.000926915	3.366221326	0.000242653	11.25338899	7.99868E-05	1.464348181	0.000790802	0	0.002748377	0	0.00094037	1.083420679	0.005050094	581.9258697	613.723428	0.306861714
	Jack	0.002121449	54.30177924	0.002139557	1.609665938	0.001566784	0	0.003542346	12.86452461	0.000927334	43.00653033	0.000305682	5.596228347	0.00302217	0	0.010503338	0	0.003593766	4.140456206	0.019299698	2223.917843	2345.437027	1.172718514
	Jones	0.040718722	1042.259088	0.000815354	0.613420549	0.030072592	0	0.001362147	4.946827986	0.00030076	13.94821343	0.000291082	5.32893728	0.008372468	0	0.001296587	0	0.000287974	0.331780603	0.001482142	170.7883116	1238.216579	0.61910829
	Lamar	0.000950838	24.33817497	0.000958954	0.721455757	0.000702236	0	0.001587687	5.765907769	0.000415633	19.27561996	0.000137007	2.508241656	0.001354543	0	0.004707619	0	0.001610734	1.855761432	0.008650166	996.7647898	1051.229951	0.525614976
	Limestone	0.000719757	18.42329542	0.000891528	0.670728366	0.000531572	0	0.000300183	1.090156782	0.00545518	252.9923553	0.001239347	22.68917849	0.000497945	0	0.00031596	0	0.000380962	0.438914787	0.000523179	60.28629516	356.5909243	0.178295462
	Llano	0.001238174	31.69299001	0.047274044	35.56597012	0.000914447	0	0.082844655	300.8619059	0.000765714	35.51115798	0.002200214	40.28013466	0.000657172	0	0.001148571	0	0.000248641	0.286464175	0.001135861	130.8861051	575.0847279	0.287542364
	McLennan	0.024534317	627.9940467	0.024743738	18.61560781	0.018119687	0	0.040966843	148.7767984	0.010724513	497.3657473	0.003535175	64.71975936	0.034951066	0	0.121469933	0	0.041561501	47.88391622	0.22319886	25719.36288	27124.71876	13.56235938
	Milam	0.002245405	57.4746346	0.002264571	1.703718789	0.001658332	0	0.003749326	13.61619935	0.000981518	45.51940379	0.000323543	5.923216216	0.003198756	0	0.011117048	0	0.00380375	4.382383245	0.02042738	2353.86146	2482.481016	1.241240508
	Mitchell	0.014943169	382.493668	0.015070721	11.3382478	0.011036196	0	0.024951762	90.61580067	0.006532002	302.9316123	0.002153177	39.41900132	0.02128772	0	0.07398395	0	0.025313952	29.16475857	0.135944204	15664.94698	16520.91007	8.260455036
	Nolan	0.000564654	14.45319062	0.000569473	0.428435476	0.000417022	0	0.000942846	3.424076134	0.000246823	11.44679952	8.13615E-05	1.489515743	0.000804394	0	0.002795613	0	0.000956532	1.102041289	0.005136889	591.9273539	624.2714127	0.312135706
	Palo Pinto	0.003206998	82.08811543	0.005906709	4.443830552	0.002368511	0	0.009454195	34.33422818	0.003962005	183.7440401	0.001143513	20.93471146	0.030749889	0	0.123082087	0	0.001262858	1.454966345	0.005748375	662.3893373	989.3892293	0.494694615
	Pecos	4.09677E-05	1.048631523	4.13174E-05	0.031084551	3.02565E-05	0	6.84069E-05	0.248429171	1.79079E-05	0.830506919	5.90308E-06	0.108069782	5.83617E-05	0	0.000202832	0	6.93999E-05	0.079957102	0.0003727	42.94648142	45.29316047	0.02264658
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.000737708	18.88277792	0.000835096	0.628273174	0.00054483	0	0.000735917	2.67258533	0.003149678	146.0711407	0.000730875	13.38040458	0.00076086	0	0.001866305	0	0.191632518	220.7840225	0.003397737	391.5236901	793.9428943	0.396971447
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0.005696437	145.8091831	0.005745061	4.322217039	0.004207073	0	0.009511781	34.54335843	0.002490043	115.4795873	0.000820806	15.02679093	0.008115023	0	0.028203184	0	0.00964985	11.11780398	0.051822854	5971.584145	6297.883086	3.148941543
	Tom Green	0.001482448	37.94556586	2.96846E-05	0.022332825	0.001094854	0	4.95918E-05	0.180099353	1.09498E-05	0.507813132	1.05974E-05	0.19401082	0.000304817	0	4.72049E-05	0	1.04843E-05	0.012079149	5.39604E-05	6.217896494	45.07979763	0.022539899
	Upton	3.11661E-05	0.797745539	3.14322E-05	0.023647546	2.30176E-05	0	5.20405E-05	0.188992281	1.36234E-05	0.631807433	4.49076E-06	0.082213995	4.43986E-05	0	0.000154304	0	5.27959E-05	0.060827297	0.000283531	32.67149923	34.45673333	0.017228367
	Ward	0.018559529	475.0600294	0.01871795	14.08218954	0.013707039	0	0.030990277	112.54551	0.008112796	376.2433542	0.002674262	48.95869786	0.026439509	0	0.091888626	0	0.03144012	36.22285079	0.16884373	19455.98267	20519.0953	10.25954765
	Webb	0.020014327	512.2978652	0.000400768	0.301512399	0.014781473	0	0.000669531	2.431496589	0.000147832	6.855915242	0.000143074	2.619313398	0.004115289	0	0.000637307	0	0.000141547	0.163078928	0.000728512	83.94696529	608.6161471	0.304308074
	Wharton	0.00014434	3.694599265	0.000178787	0.134507561	0.000106601	0	6.01986E-05	0.218619544	0.001093979	50.7349716	0.000248538	4.550077512	9.98576E-05	0	6.33625E-05	0	7.6398E-05	0.088019771	0.000104918	12.08978615	71.5105814	0.035755291
	Wichita	0.000207633	5.314695266	0.000209406	0.157543345	0.000153346	0	0.000346701	1.259093698	9.07612E-05	4.209191786	2.99181E-05	0.547721432	0.00029579	0	0.001027996	0	0.000351734	0.405240184	0.001888925	217.6622165	229.5557022	0.114777851
	Wilbarger	0.028616818	732.4920115	0.000573025	0.431107444	0.021134796	0	0.000957307	3.476594279	0.000211372	9.802701684	0.00020457	3.745137877	0.005884109	0	0.000911232	0	0.000202386	0.233172965	0.001041639	120.0287677	870.2094935	0.435104747
	Wise	0.002844488	72.80908734	0.002882008	2.16823872	0.002100781	0	0.00476997	17.32281236	0.001256075	58.25242144	0.000413241	7.565361234	0.004181914	0	0.014614274	0	0.004797945	5.527817073	0.025761411	2968.505674	3132.151412	1.566075706
	Young	0.006235856	159.6164509	0.006289085	4.731505443	0.004605458	0	0.010412491	37.81441029	0.002725836	126.4148216	0.000898531	16.44973921	0.008883468	0	0.030873859	0	0.010563634	12.17059429	0.056730171	6537.057865	6894.255386	3.447127693
	Total	**1.121837219**	**28715.17018**	**1.172570094**	**882.1668247**	**1.090766584**	**0**	**1.189130767**	**4318.494059**	**1.629360006**	**75564.06999**	**1.542362643**	**28236.60382**	**1.359385821**	**0**	**1.231642808**	**0**	**1.221806085**	**1407.669558**	**1.528786947**	**176163.2035**	**315287.3779**	**157.643689**
Energy Savings by PCA (MWh)		25,597		752		0		3,632		46,377		18,307		0		0		1,152		115,231			

Table 59: Annual and OSD Electricity Savings for the Different Programs

PROGRAM	ANNUAL															
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family (MWh)	225,389	1,001,051	1,197,537	1,256,764	1,252,530	1,247,084	1,240,311	1,232,099	1,222,335	1,210,907	1,197,702	1,182,608	1,165,511	1,146,299	1,124,859	1,101,079
ESL-Multifamily (MWh)	9,228	37,821	51,312	63,156	165,765	264,701	359,882	451,226	538,652	622,078	701,421	776,601	847,536	914,144	976,342	1,034,050
ESL-Commercial (MWh)	63,456	129,063	192,036	231,649	270,392	308,184	344,944	380,592	415,047	448,228	480,055	510,445	539,320	566,597	592,196	616,037
Federal Buildings (MWh)	52,276	109,073	159,415	206,960	251,708	293,659	332,813	369,171	402,732	433,496	461,464	486,635	509,009	528,586	545,366	559,350
Furnace Pilot Light Program (MMBtu)	2,209,050	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904
PUC (SB7) (MWh)	302,192	1,362,701	1,630,383	2,003,432	2,336,446	2,647,008	2,935,118	3,200,777	3,443,984	3,664,739	3,863,043	4,038,895	4,192,295	4,323,244	4,431,741	4,517,786
PUC (SB5 grant program) (MWh)	0	13,633	12,827	12,021	11,215	10,409	9,603	8,797	7,991	7,186	6,380	5,574	4,768	3,962	3,156	2,350
SECO (MWh)	115,360	293,764	353,701	445,357	457,921	468,611	477,428	484,371	489,440	492,636	493,959	493,408	490,983	486,685	480,513	472,468
Wind-ERCOT (MWh)	2,867,049	6,699,696	9,193,504	15,171,518	18,808,351	20,647,822	21,127,684	21,767,500	22,426,692	23,105,846	23,805,568	24,526,479	25,269,222	26,034,457	26,822,866	27,635,151
SEER13-Single Family (MWh)	0	374,246	624,639	913,010	1,185,311	1,441,594	1,681,860	1,906,108	2,114,339	2,306,551	2,482,746	2,642,923	2,787,083	2,915,224	2,803,568	2,590,509
SEER13-Multifamily (MWh)	0	31,634	52,532	76,375	98,620	119,281	138,371	155,904	171,894	186,354	199,298	210,738	220,690	229,165	219,722	202,900
Total Annual (MWh)	3,634,950	10,052,682	13,467,886	20,380,242	24,838,259	27,448,353	28,648,014	29,956,545	31,233,106	32,478,021	33,691,636	34,874,306	36,026,417	37,148,363	38,000,329	38,731,680
Total Annual (MMBtu)	2,209,050	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904

PROGRAM	OZONE SEASON DAY - OSD															
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family (MWh)	776	5,537	6,519	6,904	6,981	7,227	7,274	7,312	7,338	7,353	7,356	7,346	7,322	7,284	7,230	7,160
ESL-Multifamily (MWh)	36	192	271	351	829	1,295	1,738	2,162	2,568	2,956	3,324	3,673	4,001	4,310	4,598	4,865
ESL-Commercial (MWh)	0	800	1,189	1,447	1,700	1,966	2,205	2,436	2,660	2,876	3,082	3,280	3,467	3,645	3,811	3,967
Federal Buildings (MWh)	0	299	437	567	690	805	912	1,011	1,103	1,188	1,264	1,333	1,395	1,448	1,494	1,532
Furnace Pilot Light Program (MMBtu)	5,819	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983
PUC (SB7) (MWh)	828	3,733	4,467	5,489	6,401	7,252	8,041	8,769	9,436	10,040	10,584	11,065	11,486	11,845	12,142	12,377
PUC (SB5 grant program) (MWh)	0	37	35	33	31	29	26	24	22	20	17	15	13	11	9	6
SECO (MWh)	316	805	969	1,220	1,255	1,284	1,308	1,327	1,341	1,350	1,353	1,352	1,345	1,333	1,316	1,294
Wind-ERCOT (MWh)	5,836	14,936	20,763	25,575	37,261	40,905	41,856	43,123	44,429	45,775	47,161	48,589	50,060	51,576	53,138	54,748
SEER13-Single Family (MWh)	0	2,666	4,449	6,503	8,442	10,268	11,979	13,576	15,059	16,428	17,683	18,824	19,851	20,764	19,969	18,451
SEER13-Multifamily (MWh)	0	213	354	514	664	803	931	1,049	1,157	1,254	1,341	1,418	1,485	1,542	1,479	1,365
Total Annual (MWh)	7,792	29,218	39,453	48,603	64,254	71,834	76,270	80,789	85,113	89,240	93,165	96,895	100,425	103,758	105,186	105,765
Total Annual (MMBtu)	5,819	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983

Table 60: Annual and OSD NOx Emissions Reduction Values for the Different Programs

PROGRAM	ANNUAL (in tons NOx)															
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	158	708	843	883	879	874	869	862	854	845	835	823	810	796	780	762
ESL-Multifamily	6	26	35	44	119	191	261	328	392	453	511	566	618	667	712	755
ESL-Commercial	44	90	136	164	192	218	245	270	295	319	341	363	384	403	421	438
Federal Buildings	40	84	122	158	193	225	255	283	308	332	353	373	390	405	418	428
Furnace Pilot Light Program	102	117	117	117	117	117	117	117	117	117	117	117	0	0	0	0
PUC (SB7)	237	1,074	1,157	1,421	1,633	1,830	2,012	2,179	2,332	2,471	2,594	2,703	2,797	2,876	2,941	3,367
PUC (SB5 grant program)	0	6	5	5	5	4	4	4	3	3	3	2	2	2	1	1
SECO	67	224	270	340	349	357	364	369	373	376	377	376	374	371	366	360
Wind-ERCOT	2,465	4,152	5,688	8,914	10,957	12,029	12,308	12,681	13,065	13,461	13,868	14,288	14,721	15,167	15,626	16,099
SEER13-Single Family	0	258	430	629	816	993	1,158	1,313	1,456	1,589	1,710	1,820	1,920	2,008	1,931	1,784
SEER13-Multifamily	0	22	36	53	68	82	95	107	118	128	137	145	152	158	151	140
Total Annual (Tons NOx)	3,119	6,761	8,839	12,728	15,328	16,920	17,688	18,513	19,313	20,094	20,846	21,576	22,168	22,853	23,347	24,134

PROGRAM	OZONE SEASON DAY - OSD (in tons NOx/day)															
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0.76	3.85	4.50	4.76	4.81	4.98	5.00	5.02	5.04	5.04	5.04	5.03	5.01	4.98	4.94	4.89
ESL-Multifamily	0.03	0.13	0.18	0.24	0.58	0.92	1.24	1.55	1.84	2.12	2.39	2.64	2.88	3.11	3.31	3.51
ESL-Commercial	0.26	0.55	0.82	1.00	1.17	1.36	1.52	1.68	1.84	1.98	2.13	2.26	2.39	2.52	2.63	2.74
Federal Buildings	0.11	0.22	0.32	0.42	0.51	0.59	0.67	0.74	0.81	0.87	0.93	0.98	1.02	1.06	1.10	1.12
Furnace Pilot Light Program	0.28	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.00	0.00	0.00	0.00
PUC (SB7)	0.64	2.61	3.10	3.81	4.38	4.91	5.40	5.85	6.27	6.64	6.97	7.26	7.52	7.73	7.91	8.04
PUC (SB5 grant program)	0.00	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
SECO	0.18	0.61	0.73	0.92	0.95	0.97	0.99	1.00	1.01	1.02	1.02	1.02	1.02	1.01	0.99	0.98
Wind-ERCOT	5.85	9.27	12.98	15.13	21.79	23.93	24.48	25.22	25.99	26.77	27.59	28.42	29.28	30.17	31.08	32.02
SEER13-Single Family	0.00	1.81	3.03	4.42	5.74	6.98	8.15	9.23	10.24	11.17	12.03	12.80	13.50	14.12	13.58	12.55
SEER13-Multifamily	0.00	0.15	0.24	0.35	0.45	0.55	0.63	0.71	0.79	0.85	0.91	0.97	1.01	1.05	1.01	0.93
Total OSD (Tons NOx)	8.11	19.54	26.24	31.38	40.71	45.52	48.41	51.33	54.16	56.79	59.34	61.71	63.64	65.75	66.55	66.78

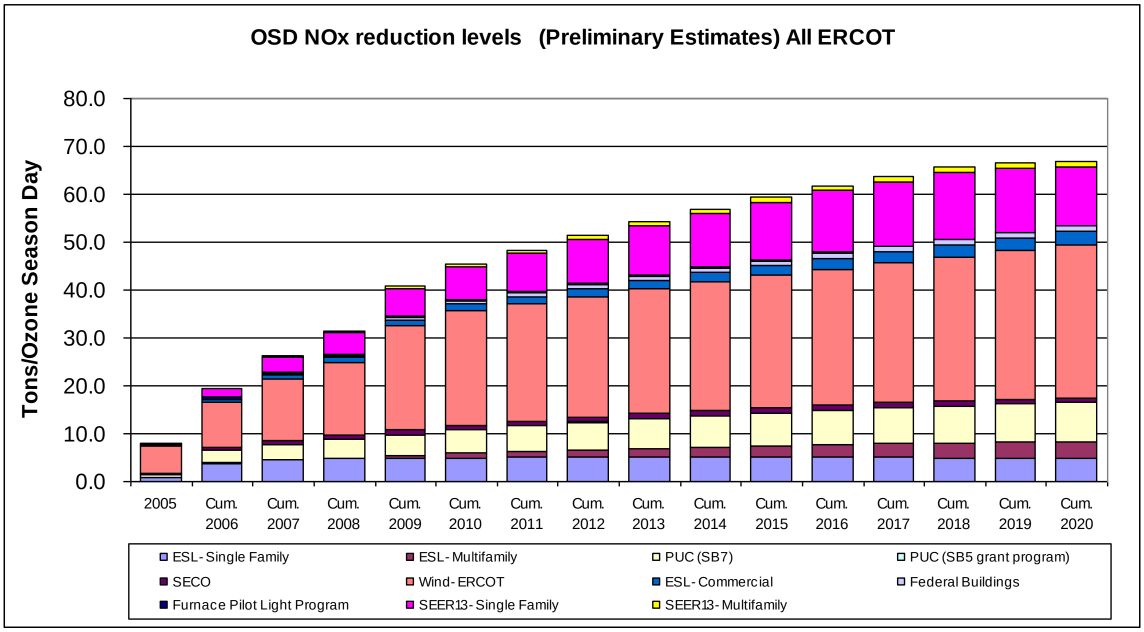

Figure 103: Cumulative OSD NOx Emissions Reduction Projections through 2020

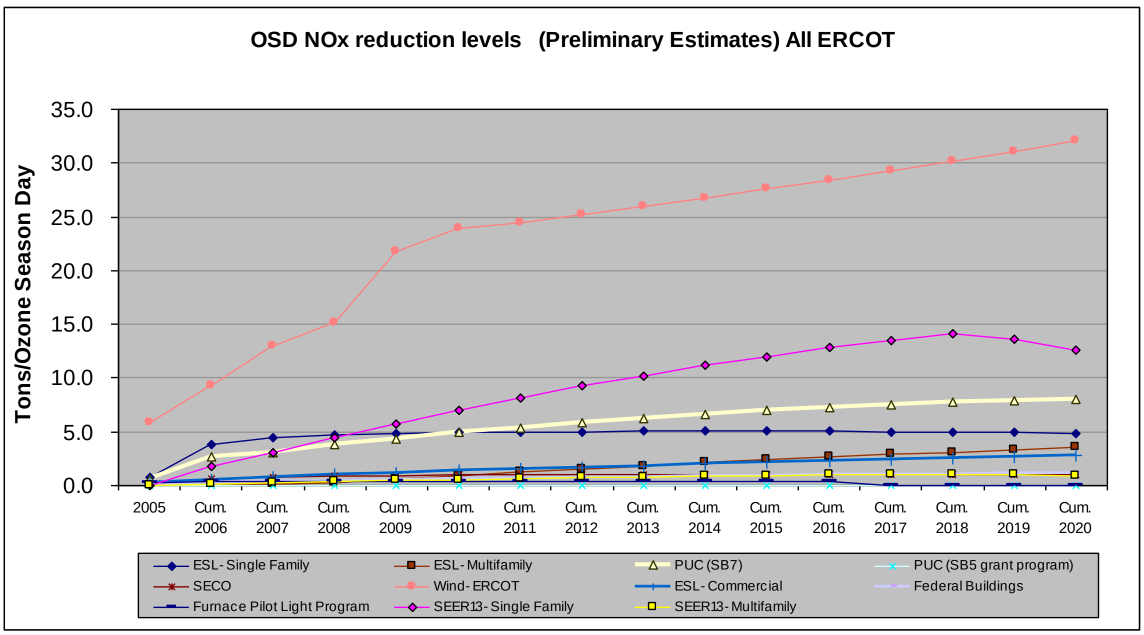

Figure 104: Cumulative OSD NOx Emissions Reduction Projections through 2020

8.5 Weather Data

In order to calculate the NOx emissions from energy efficiency and renewable energy (EE/RE) projects in non-attainment and affected counties in Texas, several weather data sets needed to be assembled from the many different weather sources (Figure 105 and Figure 106), including hourly weather data sets needed for the DOE-2 simulations and daily average weather data for analysis that used monthly utility billing data. In 2008 these sources were updated.

In the archive the counties were grouped according to the nearest TMY2 weather station. Next, for each group, weather files were determined for F-CHART, PV F-CHART, ASHRAE 90.1-1989, and ASHRAE 90.1-1999 analysis. Finally, as shown in Table 62, weather files were assigned for NOAA data (temperature, humidity, wind speed) and NREL (solar radiation). In some instances, where solar radiation data were not available from the NREL database, TCEQ solar data were used. For NREL solar sources, solar data included global horizontal, direct normal beam, and diffuse solar radiation. For TCEQ solar sources, only global horizontal solar radiation data were available which required synthesis of direct normal beam and diffuse radiation using an iterative kt procedure (Erbs 1982). Synthetic beam and diffuse solar data were also used to fill missing NREL data.

In 2005, at the request of the TCEQ, the 9 weather stations assembled for calculating emissions from the non-attainment and affected counties were expanded to include all counties in ERCOT. To accomplish this, 8 additional weather stations were added to the original 9 stations for a total of 17 weather stations (Table 63). Assignment of weather stations was then performed as shown in Table 64, with additional details provided in Table 65. Figure 107 shows an updated map of Texas showing the available weather files, 2000/2001 IECC weather zones, and ERCOT county outline. Figure 108 shows the clustering of the counties around their chosen TMY2 and NOAA weather stations. Figure 109 shows the 2000/2001 and 2006 IECC weather zones and available weather files. During the period from July 2008 to August 2009, the Laboratory maintained and added additional years of weather data to the archive.

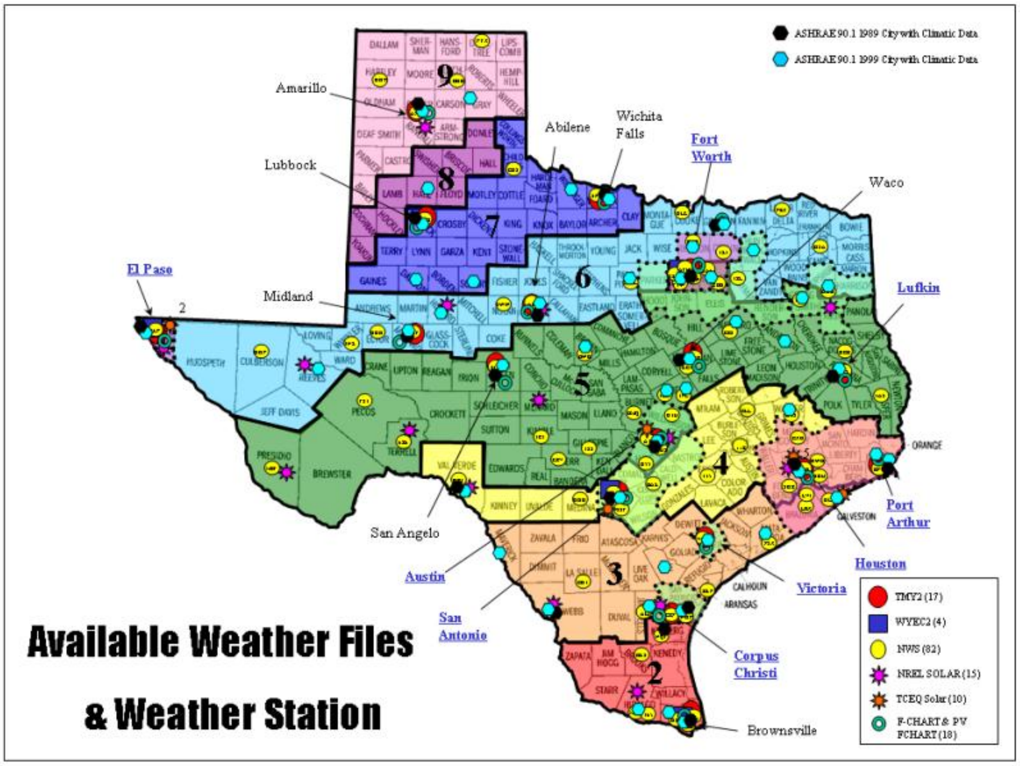

Figure 105: Available Weather Stations in Texas for 41 Non-attainment and Affected Counties

List of Available Weather Files and Weather Stations of Texas

Texas Weather Stations (NOAA)

1 Abilene Regional Airport (ABI)
2 Alice International Airport (ALI)
3 Amarillo International Airport (AMA)
4 Angleton / Lake Jackson Brazori (LBX)
5 Arlington Municipal Airport (GKY)
6 Austin - Bergstrom International (AUS)
7 Austin Camp Mabry (ATT)
8 Borger Hutchinson County Airport (BGD)
9 BRENHAM: BRENHAM MUNICIPAL AIRPORT (11R)
10 Brownsville S Padre Isl International (BRO)
11 BROWNWOOD: BROWNWOOD REGIONAL AIRPORT (BWD)
12 Burnet Municipal Airport (BMQ)
13 Childress Municipal Airport (CDS)
14 College Station (CLL)
15 Conroe Montgomery County Airport (CXO)
16 Corpus Christi International Airport (CRP)
17 CORPUS CHRISTI: CORPUS CHRISTI NAS/TRUAX FIELD ARPT (NGP)
18 Corsicana Campbell Field (CRS)
19 Cotulla La Salle Co Airport (COT)
20 Dalhart Municipal Airport (DHT)
21 Dallas - Fort Worth International Airport (DFW)
22 Dallas Love Field (DAL)
23 Dallas Redbird Airport (RBD)
24 Del Rio International Airport (DRT)
25 Denton Municipal Airport (DTO)
26 Dryden Terrell County Airport (6R6)
27 El Paso International Airport (ELP)
28 FALFURRIAS: BROOKS COUNTY AIRPORT (BKS)
29 Fort Stockton Pecos County Airport (FST)
30 Fort Worth Alliance Airport (AFW)
31 Fort Worth Meacham (FTW)
32 FREDERICKSBURG: GILLESPIE COUNTY AIRPORT (T82)
33 GAINESVILLE: GAINESVILLE MUNICIPAL AIRPORT (GLE)
34 Galveston Scholes Field (GLS)
35 GEORGETOWN: GEORGETOWN MUNICIPAL AIRPORT (GTU)
36 Harlingen Rio Grande Valley I (HRL)
37 Hondo Municipal Airport (HDO)
38 Houston Bush Intercontinental (IAH)
39 Houston Clover Field (LVJ)
40 Houston Hooks Memorial Airport (DWH)
41 Houston Sugarland Mem (SGR)
42 Houston William P Hobby Airport (HOU)
43 Huntsville Municipal Airport (UTS)
44 JASPER: JASPER COUNTY-BELL FIELD AIRPORT (JAS)
45 Junction Kimble County Airport (JCT)
46 KERRVILLE: KERRVILLE MUNI/LOUIS SCHREINER FLD AIRPORT (ERV)
47 KILLEEN: KILLEEN MUNICIPAL AIRPORT (ILE)
48 KINGSVILLE: KINGSVILLE NAS AIRPORT (NQI)
49 LA GRANGE: FAYETTE REGIONAL AIR CENTER AIRPORT (3T5)
50 Longview E Tx Rgnl Airport (GGG)
51 Lubbock International Airport (LBB)
52 Lufkin Angelina Cty Airport (LFK)
53 MARFA: MARFA MUNICIPAL AIRPORT (MRF)
54 McAllen Miller International Airport (MFE)
55 McKinney Municipal Airport (TKI)
56 Midland International Airport (MAF)
57 Mineral Wells Airport (MWL)
58 MOUNT PLEASANT: MOUNT PLEASANT REGIONAL AIRPORT (OSA)
59 NACOGDOCHES: A L MANGHAM JR REGIONAL AIRPORT (OCH)
60 New Braunfels Municipal Airport (BAZ)
61 Odessa Schlemeyer Field (ODO)
62 Palacios Municipal Airport (PSX)
63 PARIS: COX FIELD AIRPORT (PRX)
64 PERRYTON: PERRYTON OCHILTREE COUNTY AIRPORT (PYX)
65 Pine Springs Guadalupe Mounta (GDP)
66 Port Arthur Se Tx Rgnl Airport (BPT)
67 Port Isabel Cameron County Airport (PIL)
68 Rockport Aransas Co Airport (RKP)
69 San Angelo Mathis Field (SJT)
70 San Antonio International Airport (SAT)
71 San Antonio Stinson Municipal Airport (SSF)
72 SAN MARCOS: SAN MARCOS MUNICIPAL AIRPORT (HYI)
73 SWEETWATER: AVENGER FIELD AIRPORT (SWW)
74 TEMPLE: DRAUGHON-MILLER CNTRL TEXAS REGIONAL ARPT (TPL)
75 Terrell Municipal Airport (TRL)
76 Tyler Pounds Field (TYR)
77 Victoria Regional Airport (VCT)
78 WACO: MC GREGOR EXECUTIVE AIRPORT (PWG)
79 Waco Regional Airport (ACT)
80 WESLACO: MID VALLEY AIRPORT (T65)
81 Wichita Falls Municipal Airport (SPS)
82 Wink Winkler Co Airport (INK)

Texas TMY2 Weather Files

1 Abilene
2 Amarillo
3 Austin
4 Brownsville
5 Corpus Christi
6 El Paso
7 Fort Worth
8 Houston
9 Lubbock
10 Lufkin
11 Midland
12 Port Arthur
13 San Angelo
14 San Antonio
15 Victoria
16 Waco
17 Wichita Falls

Texas WYEC2 Weather Files

1 El Paso
2 Brownsville
3 Fort Worth
4 San Antonio

NREL Solar Stations

1 Abilene
2 Austin
3 Big Spring
4 Canyon
5 Clear Lake
6 Corpus Christi
7 Del Rio
8 Edinburg
9 El Paso
10 Laredo
11 Menard
12 Overton
13 Pecos
14 Presidio
15 Sanderson

TCEQ Solar Stations

1 Bexar
2 Travis
3 El Paso (2)
4 Galveston
5 Harris (5)

FCHART and PV FCHART (New Weather File)

1 ABILENE
2 AMARILLO
3 AUSTIN
4 BROWNSVILLE
5 CORPUS CHRISTI
6 EL PASO
7 FORT WORTH
8 HOUSTON
9 LUBBOCK
10 LUFKIN
11 MIDLAND-ODESSA
12 PORT ARTHUR
13 SAN ANGELO
14 SAN ANTONIO
15 SHERMAN
16 VICTORIA
17 WACO
18 WICHITA FALLS

Figure 106: List of Available Weather Files in Texas (Listed by Symbol)

Table 61: Assignment of Weather Stations for 41 Non-attainment and Affected Counties (NOAA, TMY2, F-CHART, PV F-CHART, NAHB, Climate Zone, HDD, CDD, 90.1-1989, 90.1-1999)

Area	No.	County	NOAA Weather Station		Solar Station		TMY2		FCHART		PV-FCHART		DOE Include File	Weather File	DOE TRY weather file name	East or West Texas	Climate Zone	HDD		CDD		AHSRAE 90.1-1989		AHSRAE 90.1-1999		County
			WBAN No.	Weather Station	Source	File	WBAN No.	File										1989	1999	1989	1999	Nearest City	Table 8A (10, 12, 16)	Nearest City	Table B (5, 6, 8, 10)	
	ID	County	WBAN No.	Weather Station	x	x	x	TMY2File	Fchart	FchartID	PVFChart	PVFChartID	DOE_INC	x	DOE_WF	PRECODE	CZ									County
Austin	22	Bastrop	13958	Austin Camp Mabry (ATT)	NREL	Austin	13958	Austin	Austin	14	Austin	18	BAS	Austin	ATT	West	4					Austin	12	Austin	6	Bastrop
	26	Caldwell	13958	Austin Camp Mabry (ATT)	NREL	Austin	13958	Austin	Austin	14	Austin	18	CAL	Austin	ATT	West	4					Austin	12	Austin	6	Caldwell
	8	Hays	13958	Austin Camp Mabry (ATT)	NREL	Austin	13958	Austin	Austin	14	Austin	18	HAY	Austin	ATT	West	5					Austin	12	Austin	6	Hays
	40	Travis	13958	Austin Camp Mabry (ATT)	NREL	Austin	13958	Austin	Austin	14	Austin	18	TRA	Austin	ATT	West	5	1735	1688	6873	7171	Austin	12	Austin	6	Travis
	41	Williamson	13958	Austin Camp Mabry (ATT)	NREL	Austin	13958	Austin	Austin	14	Austin	18	WLL	Austin	ATT	West	5					Austin	12	Kileen/Robert-gray or **Austin**	6	Williamson
Corpus	38	Nueces	12924	Corpus Christi International Airport (CRP)	NREL	Corpus Christi	12924	Corpus Christi	Corpus Christi	52	Corpus Christi	58	NUE	Corpus Christi	CRP	East	3	889	1016	8200	8023	Corpus Christi	16	Corpus Christi or Alice	5	Nueces
	15	San Patricio	12924	Corpus Christi International Airport (CRP)	NREL	Corpus Christi	12924	Corpus Christi	Corpus Christi	52	Corpus Christi	58	SAP	Corpus Christi	CRP	East	3					Corpus Christi	16	Corpus Christi or Alice	5	San Patricio
El Paso	30	El Paso	23044	El Paso International Airport (ELP)	TCEQ	C12-El Paso UTEP	23044	El Paso	El Paso	68	El Paso	70	ELP	El Paso	ELP	West	6	2605	2708	5617	5488	El Paso	12	El Paso	10	El Paso
Dallas-Ft. Worth	27	Collin	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	COL	Fort Worth	DFW	West	6					Sherman or Fort Worth	12	**Denton,** Greenville or Sherman	8	Collin
	4	Dallas	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	DAL	Fort Worth	DFW	West	5		2259		6587	Fort Worth	12	Dallas	8	Dallas
	29	Denton	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	DEN	Fort Worth	DFW	West	6					Shermanor Fort Worth	12	Denton	8	Denton
	31	Ellis	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	ELL	Fort Worth	DFW	West	5					Fort Worth	12	Fort Worth, Dallas or Corsicana	8	Ellis
	23	Hood	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	HOD	Fort Worth	DFW	West	5					Fort Worth	12	Mineral Wells or Fort Worth	8	Hood
	24	Hunt	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	HNT	Fort Worth	DFW	West	6					Shermanor Fort Worth	12	Greenville	10	Hunt
	36	Johnson	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	JOH	Fort Worth	DFW	West	5					Fort Worth	12	Mineral Wells or Fort Worth	8	Johnson
	10	Kaufman	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	KAU	Fort Worth	DFW	West	6					Fort Worth	12	Greenville, **Dallas** or Corsicana	8	Kaufman
	39	Parker	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	PAR	Fort Worth	DFW	West	6					Fort Worth	12	Mineral Wells or Fort Worth	8	Parker
	13	Rockwall	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	ROC	Fort Worth	DFW	West	6					Shermanor Fort Worth	12	**Dallas** or Greeenville	8	Rockwall
	17	Tarrant	03927	Dallas - Fort Worth International Airpor (DFW)	NREL	Overton	03927	Fort Worth	Fort Worth	78	Fort Worth	83	TAR	Fort Worth	DFW	West	5	2354		6174		Fort worth	12	Fort worth	8	Tarrant
Houston/Galveston	2	Brazoria	12960	Houston Bush Intercontinental (IAH)	NREL	Clear Lake	12960	Houston	Houston	96	Houston	102	BRA	Houston	IAH	East	3					Houston	10	Houston, Galveston or Bay City	5	Brazoria
	5	Fort Bend	12960	Houston Bush Intercontinental (IAH)	NREL	Clear Lake	12960	Houston	Houston	96	Houston	102	FOB	Houston	IAH	East	4					Houston	10	Houston or Bay City	5	Fort Bend
	32	Galveston	12960	Houston Bush Intercontinental (IAH)	NREL	Clear Lake	12960	Houston	Houston	96	Houston	102	GAL	Houston	IAH	East	3		1263		7378	Houston	10	Galveston	5	Galveston
	34	Harris	12960	Houston Bush Intercontinental (IAH)	NREL	Clear Lake	12960	Houston	Houston	96	Houston	102	HAR	Houston	IAH	East	4	1346	1371	7125	7357	Houston	10	Houston	5	Harris
	37	Montgomery	12960	Houston Bush Intercontinental (IAH)	NREL	Clear Lake	12960	Houston	Houston	96	Houston	102	MOG	Houston	IAH	East	4					Houston	10	Huntsville or **Houston**	5	Montgomery
	20	Waller	12960	Houston Bush Intercontinental (IAH)	NREL	Clear Lake	12960	Houston	Houston	96	Houston	102	WAL	Houston	IAH	East	4					Houston	10	Houston	5	Waller
Tyler/Longview	33	Gregg	03901	Longview E Tx Rgnl Airport (GGG)	NREL	Overton	93987	Lufkin	Lufkin	125	Lufkin	131	GRE	Lufkin	GGG	East	6					Lufkin	12	Longview	8	Gregg
	35	Harrison	03901	Longview E Tx Rgnl Airport (GGG)	NREL	Overton	93987	Lufkin	Lufkin	125	Lufkin	131	HAN	Lufkin	GGG	East	6					Lufkin	12	Longview	8	Harrison
	9	Henderson	03901	Longview E Tx Rgnl Airport (GGG)	NREL	Overton	93987	Lufkin	Lufkin	125	Lufkin	131	HDS	Lufkin	GGG	East	5					Lufkin, Waco or Fort Worth	12	Tyler, Palestine or Corsicana	8	Henderson
	14	Rusk	03901	Longview E Tx Rgnl Airport (GGG)	NREL	Overton	93987	Lufkin	Lufkin	125	Lufkin	131	RUS	Lufkin	GGG	East	5					Lufkin	12	Tyler or Longview	8	Rusk
	16	Smith	03901	Longview E Tx Rgnl Airport (GGG)	NREL	Overton	93987	Lufkin	Lufkin	125	Lufkin	131	SMI	Lufkin	GGG	East	5		1296		6562	Lufkin	12	Tyler	8	Smith
	18	Upshur	03901	Longview E Tx Rgnl Airport (GGG)	NREL	Overton	93987	Lufkin	Lufkin	125	Lufkin	131	UPS	Lufkin	GGG	East	6					Lufkin	12	Tyler or Longview	8	Upshur
Beaumont Pt. Arthur	3	Chambers	12917	Port Arthur Se Tx Rgnl Airport (BPT)	TCEQ	C34-Galveston Airport	12917	Port Arthur	Port Arthur	166	Port Arthur	172	CHA	Port Arthur	BPT	East	4					Houston or Port Arthur	10	Beaumont or **Houston**	5	Chambers
	7	Hardin	12917	Port Arthur Se Tx Rgnl Airport (BPT)	TCEQ	C34-Galveston Airport	12917	Port Arthur	Port Arthur	166	Port Arthur	172	HAD	Port Arthur	BPT	East	4					Port Arthur	10	Beaumont	6	Hardin
	25	Jefferson	12917	Port Arthur Se Tx Rgnl Airport (BPT)	TCEQ	C34-Galveston Airport	12917	Port Arthur	Port Arthur	166	Port Arthur	172	JEF	Port Arthur	BPT	East	4	1416	1677	6888	6703	Port Arthur	10	Beaumont	6	Jefferson
	11	Liberty	12917	Port Arthur Se Tx Rgnl Airport (BPT)	TCEQ	C34-Galveston Airport	12917	Port Arthur	Port Arthur	166	Port Arthur	172	LIB	Port Arthur	BPT	East	4					Houston or Port Arthur	10	Beaumont, Galveston or **Houston**	5	Liberty
	12	Orange	12917	Port Arthur Se Tx Rgnl Airport (BPT)	TCEQ	C34-Galveston Airport	12917	Port Arthur	Port Arthur	166	Port Arthur	172	ORA	Port Arthur	BPT	East	4					Port Arthur	10	Beaumont	6	Orange
San Antonio	1	Bexar	12921	San Antonio International Airport (SAT)	TCEQ	C58-Camp Bullis	12921	San Antonio	San Antonio	187	San Antonio	194	BEX	San Antonio	SAT	West	4	1579	1644	7170	7142	San Antonio	12	San Antonio	6	Bexar
	28	Comal	12921	San Antonio International Airport (SAT)	TCEQ	C58-Camp Bullis	12921	San Antonio	San Antonio	187	San Antonio	194	COM	San Antonio	SAT	West	4					San Antonio	12	San Antonio	6	Comal
	6	Guadalupe	12921	San Antonio International Airport (SAT)	TCEQ	C58-Camp Bullis	12921	San Antonio	San Antonio	187	San Antonio	194	GUA	San Antonio	SAT	West	4					San Antonio	12	San Antonio	6	Guadalupe
	21	Wilson	12921	San Antonio International Airport (SAT)	TCEQ	C58-Camp Bullis	12921	San Antonio	San Antonio	187	San Antonio	194	WIL	San Antonio	SAT	West	4					San Antonio	12	San Antonio	6	Wilson
Victoria	19	Victoria	12912	Victoria Regional Airport (VCT)	TCEQ	C58-Camp Bullis	12912	Victoria	Victoria	347	Victoria	225	VIC	Victoria	VCT	East	3	Hou	1296	Hou	7507			Victoria	5	Victoria

Table 62: Availability of Weather Data for 41 Non-attainment and Affected County (NOAA, NREL, TCEQ, ESL)

County No.	County	Affected = A Non Attain = N Others = O	WBAN No.	NOAA	Lat. Deg.	Lat. Min.	Long. Deg.	Long. Min.	Elev. (m)	Station No.	NREL	Lat. Deg.	Lat. Min.	Long. Deg.	Long. Min.	Elev. (m)
1	Bastrop	A														
2	Bexar	A	12921	San Antonio International Airport (SAT)	N 29	32	W 98	28	246.3							
2	Bexar	A	12970	San Antonio Stinson Municipal Airport (SSF)	N 29	20	W 98	28	175.3							
3	Caldwell	A														
4	Comal	A														
5	Ellis	A														
5	Ellis	A														
6	Gregg	A	13901	Longview E Tx Rgnl Airport (GGG)	N 32	23	W 94	43	111.3							
7	Guadalupe	A	12971	New Braunfels Municipal Airport (BAZ)	N 29	43	W 98	3	196.5							
8	Harrison	A														
9	Hays	A	-	SAN MARCOS : SAN MARCOS MUNICIPAL AIRPORT (HYI)	-	-	-	-	-							
10	Johnson	A														
11	Kaufman	A	53911	Terrell Municipal Airport (TRL)	N 32	43	W 96	16	144.5							
12	Nueces	A	12924	Corpus Christi International Airport (CRP)	N 27	46	W 97	31	12.5	6	Corpus Christi					
12	Nueces	A	-	CORPUS CHRISTI : CORPUS CHRISTI NAS/TRUAX FIELD ARPT (NGP)	-	-	-	-	-							
13	Parker	A														
14	Rockwall	A														
15	Rusk	A								12	Overton					
16	San Patricio	A														
17	Smith	A	13972	Tyler Pounds Field (TYR)	N 32	21	W 95	24	165.0							
18	Travis	A	13904	Austin - Bergstrom International (AUS)	N 30	11	W 97	41	146.3	2	Austin					
18	Travis	A	13958	Austin Camp Mabry (ATT)	N 30	19	W 97	46	200.5							
18	Travis	A														
19	Upshur	A														
20	Victoria	A	12912	Victoria Regional Airport (VCT)	N 28	52	W 96	56	35.1							
21	Williamson	A	-	GEORGETOWN : GEORGETOWN MUNICIPAL AIRPORT (GTU)	-	-	-	-	-							
22	Wilson	A														
23	Henderson	A														
24	Hood	A														
25	Hunt	A														
26	Brazoria	N	12976	Angleton / Lake Jackson Brazoria (LBX)	N 29	7	W 95	28	76.0							
26	Brazoria	N	12975	Houston Clover Field (LVJ)	N 29	31	W 95	15	13.4							
27	Chambers	N														
28	Collin	N	53914	McKinney Municipal Airport (TKI)	N 33	11	W 96	35	176.3							
28	Collin	N														
29	Dallas	N	33006	Dallas Love Field (DAL)	N 32	51	W 96	51	134.1							
29	Dallas	N	03971	Dallas Redbird Airport (RBD)	N 32	41	W 96	52	200.3							
29	Dallas	N														
30	Denton	N	03991	Denton Municipal Airport (DTO)	N 33	12	W 97	12	195.7							
31	El Paso	N	23044	El Paso International Airport (ELP)	N 31	49	W 106	23	1194.2	9	El Paso					
31	El Paso	N														
31	El Paso	N														
32	Fort Bend	N	12977	Houston Sugarland Mem (SGR)	N 29	37	W 95	39	25.0							
33	Galveston	N	12923	Galveston Scholes Field (GLS)	N 29	16	W 94	52	1.5							
34	Hardin	N														
35	Harris	N	12960	Houston Bush Intercontinental (IAH)	N 29	59	W 95	22	29.0	5	Clear Lake					
35	Harris	N	53910	Houston Hooks Memorial Airport (DWH)	N 30	4	W 95	33	46.3							
35	Harris	N	12918	Houston William P Hobby Airport (HOU)	N 29	38	W 95	17	13.7							
35	Harris	N														
35	Harris	N														
35	Harris	N														
35	Harris	N														
35	Harris	N														
35	Harris	N														
35	Harris	N														
35	Harris	N														
36	Jefferson	N	12917	Port Arthur Se Tx Rgnl Airport (BPT)	N 29	57	W 94	1	4.9							
36	Jefferson	N														
36	Jefferson	N														
36	Jefferson	N														
37	Liberty	N														
38	Montgomery	N	53902	Conroe Montgomery County Airport (CXO)	N 30	21	W 95	25	74.7							
39	Orange	N														
40	Tarrant	N	53907	Arlington Municipal Airport (GKY)	N 32	40	W 97	6	192.3							
40	Tarrant	N	03927	Dallas - Fort Worth International Airport (DFW)	N 32	54	W 97	1	170.7							
40	Tarrant	N	53909	Fort Worth Alliance Airport (AFW)	N 32	58	W 97	19	208.5							
40	Tarrant	N	13961	Fort Worth Meacham (FTW)	N 32	49	W 97	22	209.4							
40	Tarrant	N														
41	Waller	N														

County No.	County	CAMS No.	TCEQ	Lat. Deg.	Lat. Min.	Long. Deg.	Long. Min.	Elev. (m)	Site No.	ESL	Lat. Deg.	Lat. Min.	Long. Deg.	Long. Min.	Elev. (m)
1	Bastrop														
2	Bexar	C58	Camp Bullis	N 29	38	W 98	34		140	UTHSC					
2	Bexar														
3	Caldwell														
4	Comal														
5	Ellis	C30	El Paso East	N 31	45	W 106	25								
5	Ellis	C94	Midlothian Tower	N 32	26	W 97	1								
6	Gregg														
7	Guadalupe														
8	Harrison														
9	Hays														
10	Johnson	C77	Cleburne Airport	N 32	21	W 97	26								
11	Kaufman	C71	Kaufman	N 32	34	W 96	19								
12	Nueces	C4	Corpus Christi West	N 27	46	W 97	26								
12	Nueces														
13	Parker	C76	Parker County (Fort Worth)	N 32	52	W 97	54								
14	Rockwall	C69	Rockwall Heath	N 32	56	W 96	26								
15	Rusk														
16	San Patricio														
17	Smith	C02	Tyler Airport relocated	N 32	21	W 95	25								
18	Travis	C38	Austin Audubon Society	N 30	29	W 97	52		202	S.F. Austin Building (SFA)					
18	Travis								217	Robert E. Johnson Elec Room (West Solar)					
18	Travis								217	Robert E. Johnson Elec Room (South Solar)					
19	Upshur														
20	Victoria	C87	Victoria	N 28	50	W 97	0								
21	Williamson														
22	Wilson														
23	Henderson														
24	Hood	C73	Granbury	N 32	27	W 97	46								
25	Hunt	C1006	Greenville	N 33	9	W 96	7								
26	Brazoria	C1016	Lake Jackson	N 29	3	W 95	26								
26	Brazoria														
27	Chambers														
28	Collin	C31	Frisco C31	N 33	8	W 96	47								
28	Collin	C68	Anna	N 33	21	W 96	33								
29	Dallas	C63	Dallas North #2 (Dallas)	N 32	55	W 96	48		794	Federal Reserve - Weather Station (FRW)					
29	Dallas	C74	Sunnyvale Long Creek (Dallas)	N 32	46	W 96	33								
29	Dallas	C401	Dallas Hinton St	N 32	49	W 96	52								
30	Denton	C56	Denton Airport South	N 33	12	W 97	12								
31	El Paso	C12	El Paso UTEP	N 31	46	W 106	30		325	Valle Verde Campus (ECV)					
31	El Paso	C37	Ascarate Park SE	N 31	45	W 106	24								
31	El Paso	C41	El Paso Chamizal	N 31	46	W 106	27								
32	Fort Bend														
33	Galveston	C34	Galveston Airport	N 29	16	W 94	51								
34	Hardin														
35	Harris	C8	Aldine	N 29	54	W 95	20		121	UT Health Science Center					
35	Harris	C15	Channelview	N 29	48	W 95	8		931	Habitat Humanity Houses					
35	Harris	C26	Northwest Harris County	N 30	2	W 95	40								
35	Harris	C35	Deer Park #2	N 29	40	W 95	8								
35	Harris	C45	Seabrook Friendship Park	N 29	35	W 95	1								
35	Harris	C53	Houston Bayland Park	N 29	42	W 95	30								
35	Harris	C81	Houston Regional Office	N 29	44	W 95	19								
35	Harris	C85	Karnack	N 32	40	W 94	10								
35	Harris	C403	Clinton (TCEC, Houston)	N 29	44	W 95	15								
35	Harris	C617	Wallisville Road	N 29	49	W 94	56								
35	Harris	C1015	Lynchburg Ferry	N 29	46	W 95	5								
36	Jefferson	C20	Port Arthur West	N 29	54	W 93	58								
36	Jefferson	C2	Beaumont Downtown	N 30	2	W 94	4								
36	Jefferson	C64	Hamshire	N 29	52	W 94	15								
36	Jefferson	C643	SETRPC 43 Jefferson County Airport	N 29	57	W 94	0	0							
37	Liberty														
38	Montgomery	C78	Conroe Airport Relocated	N 30	21	W 95	25								
39	Orange	C9	West Orange	N 30	5	W 93	46								
40	Tarrant	C61	Arlington Municipal Airport	N 32	39	W 97	5		111	University Hall (UT Arlington)					
40	Tarrant	C70	Grapevine Fairway	N 32	59	W 97	4								
40	Tarrant	C13	Fort Worth Northwest	N 32	48	W 97	21								
40	Tarrant	C17	Keller (Fort Worth)	N 32	55	W 97	17								
40	Tarrant	C75	Eagle Mountain Lake (Fort Worth)	N 32	59	W 97	25								
41	Waller														

County No.	County	WBAN No.	TMY2	Lat. Deg.	Lat. Min.	Long. Deg.	Long. Min.	Elev. (m)	NOAA 99	NOAA 00	NOAA 01	NOAA 02	NOAA 03	NREL 99	NREL 00	NREL 01	NREL 02	NREL 03	TCEQ 99	TCEQ 00	TCEQ 01	TCEQ 02	TCEQ 03	ESL 99	ESL 00	ESL 01	ESL 02	ESL 03
1	Bastrop	13958	Austin	N 30	18	W 97	42	189																				
2	Bexar	12921	San Antonio	N 29	32	W 98	28	242	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	Bexar	12922	San Antonio	N 29	32	W 98	28	242	Y	Y	Y	Y	Y															
3	Caldwell	13958	Austin	N 30	18	W 97	42	189																				
4	Comal	12923	San Antonio	N 29	32	W 98	28	242																				
5	Ellis	03936	Fort Worth	N 32	50	W 97	3	164											Y (red)									
5	Ellis	03937	Fort Worth	N 32	50	W 97	3	164													Y	Y	Y					
6	Gregg	93987	Lufkin	N 31	14	W 94	45	96	Y	Y	Y	Y	Y															
7	Guadalupe	12924	San Antonio	N 29	32	W 98	28	242	Y	Y	Y	Y	Y															
8	Harrison	93988	Lufkin	N 31	14	W 94	45	96																				
9	Hays	93989	Lufkin	N 31	14	W 94	45	96				Y (red)	Y															
10	Johnson	03930	Fort Worth	N 32	50	W 97	3	164														Y (red)	Y					
11	Kaufman	03939	Fort Worth	N 32	50	W 97	3	164	Y	Y	Y	Y	Y								Y (red)	Y	Y					
12	Nueces	12924	Corpus Christi	N 27	46	W 97	30	13	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y (red)				Y (red)	Y					
12	Nueces	12924	Corpus Christi	N 27	46	W 97	30	13	Y (red)	Y	Y	Y	Y															
13	Parker	03940	Fort Worth	N 32	50	W 97	3	164														Y (red)	Y					
14	Rockwall	03941	Fort Worth	N 32	50	W 97	3	164														Y (red)	Y					
15	Rusk	93987	Lufkin	N 31	14	W 94	45	96						Y	Y	Y	Y	Y (red)										
16	San Patricio	12924	Corpus Christi	N 27	46	W 97	30	13																				
17	Smith	93900	Lufkin	N 31	14	W 94	45	96	Y	Y	Y	Y	Y									Y (red)	Y					
18	Travis	93990	Lufkin	N 31	14	W 94	45	96	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y (red)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
18	Travis	93991	Lufkin	N 31	14	W 94	45	96	Y (red)	Y	Y	Y	Y													Y (red)	Y	Y
18	Travis	93992	Lufkin	N 31	14	W 94	45	96																		Y (red)	Y	Y
19	Upshur	93989	Lufkin	N 31	14	W 94	45	96																				
20	Victoria	12912	Victoria	N 28	51	W 96	55	32	Y	Y	Y	Y	Y									Y (red)	Y					
21	Williamson	93993	Lufkin	N 31	14	W 94	45	96				Y (red)	Y															
22	Wilson	12925	San Antonio	N 29	32	W 98	28	242																				
23	Henderson																											
24	Hood																					Y (red)	Y					
25	Hunt																						Y (red)					
26	Brazoria	12960	Houston	N 29	59	W 95	22	33	Y	Y	Y	Y	Y										Y (red)					
26	Brazoria	12960	Houston	N 29	59	W 95	22	33	Y	Y	Y	Y	Y															
27	Chambers	12917	Port Arthur	N 29	57	W 94	1	7																				
28	Collin	03937	Fort Worth	N 32	50	W 97	3	164	Y	Y	Y	Y	Y									Y (red)	Y					
28	Collin	03938	Fort Worth	N 32	50	W 97	3	164														Y (red)	Y					
29	Dallas	03927	Fort Worth	N 32	50	W 97	3	164	Y	Y	Y	Y	Y									Y (red)	Y				Y (red)	Y
29	Dallas	03928	Fort Worth	N 32	50	W 97	3	164	Y	Y	Y	Y	Y									Y (red)	Y					
29	Dallas	03929	Fort Worth	N 32	50	W 97	3	164											Y (red)	Y	Y	Y	Y					
30	Denton	03942	Fort Worth	N 32	50	W 97	3	164	Y	Y	Y	Y	Y							Y (red)	Y	Y	Y					
31	El Paso	23044	El Paso	N 31	48	W 106	24	1194	Y	Y	Y	Y	Y	Y (red)	Y	Y	Y	Y (red)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
31	El Paso	23045	El Paso	N 31	48	W 106	24	1194												Y	Y	Y	Y					
31	El Paso	23046	El Paso	N 31	48	W 106	24	1194											Y	Y	Y	Y	Y					
32	Fort Bend	12969	Houston	N 29	59	W 95	22	33		Y (red)	Y	Y	Y															
33	Galveston	12960	Houston	N 29	59	W 95	22	33	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y					
34	Hardin	12918	Port Arthur	N 29	57	W 94	1	7																				
35	Harris	12960	Houston	N 29	59	W 95	22	33	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y (red)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
35	Harris	12960	Houston	N 29	59	W 95	22	33	Y	Y	Y	Y	Y									Y (red)	Y	Y	Y	Y	Y	Y
35	Harris	12960	Houston	N 29	59	W 95	22	33	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y					
35	Harris	12961	Houston	N 29	59	W 95	22	33											Y	Y	Y	Y	Y					
35	Harris	12962	Houston	N 29	59	W 95	22	33														Y (red)	Y					
35	Harris	12963	Houston	N 29	59	W 95	22	33											Y	Y	Y	Y	Y					
35	Harris	12964	Houston	N 29	59	W 95	22	33														Y (red)	Y					
35	Harris	12965	Houston	N 29	59	W 95	22	33														Y (red)	Y					
35	Harris	12966	Houston	N 29	59	W 95	22	33											Y	Y	Y	Y	Y					
35	Harris	12967	Houston	N 29	59	W 95	22	33											-	-	-	-	-					
35	Harris	12968	Houston	N 29	59	W 95	22	33															Y (red)					
36	Jefferson	12919	Port Arthur	N 29	57	W 94	1	7	Y	Y	Y	Y	Y									Y (red)	Y					
36	Jefferson	12920	Port Arthur	N 29	57	W 94	1	7														Y (red)	Y					
36	Jefferson	12921	Port Arthur	N 29	57	W 94	1	7														Y (red)	Y					
36	Jefferson	12922	Port Arthur	N 29	57	W 94	1	7											Y (red)	Y	Y	Y	Y					
37	Liberty	12923	Port Arthur	N 29	57	W 94	1	7																				
38	Montgomery	12970	Houston	N 29	59	W 95	22	33	Y	Y	Y	Y	Y									Y (red)	Y					
39	Orange	12924	Port Arthur	N 29	57	W 94	1	7														Y (red)	Y					
40	Tarrant	03931	Fort Worth	N 32	50	W 97	3	164	Y	Y	Y	Y	Y									Y (red)	Y	Y	Y	Y	Y	Y
40	Tarrant	03932	Fort Worth	N 32	50	W 97	3	164	Y	Y	Y	Y	Y							Y (red)	Y	Y	Y					
40	Tarrant	03933	Fort Worth	N 32	50	W 97	3	164	Y	Y	Y	Y	Y							Y (red)	Y	Y	Y					
40	Tarrant	03934	Fort Worth	N 32	50	W 97	3	164	Y	Y	Y	Y	Y									Y (red)	Y					
40	Tarrant	03935	Fort Worth	N 32	50	W 97	3	164														Y (red)	Y					
41	Waller	12971	Houston	N 29	59	W 95	22	33																				

Note:

County No. The affected and non attainment county numbers are listed orderly using table 19, p. 101, of the TERP Technical Report 2003. The other county numbers are listed alphabetically.

NOAA WBAN No. Station's Weather Bureau Army Navy number

TMY2 WBAN No. Station's Weather Bureau Army Navy number

NREL Station No. The station numbers are listed alphabetically.

TECQ CAMS No. The numbers are from TECQ.

ESL Site No. ESL's site numbers.

Y in black: The whole years data is available

Y in red: The data is available for partial year

Table 63: Main NOAA Weather Stations used in eCALC

ABI	Abilene Regional Airport
AMA	Amarillo International Airport
BRO	Brownsville S. Padre Island International
LBB	Lubbock International Airport
MAF	Midland International Airport
SJT	San Angelo Mathis Field
ACT	Waco Regional Airport
SPS	Wichita Falls Municipal Airport
ATT	Austin Camp Mabry
BPT	Port Arthur Se TX Rgnl Airport
CRP	Corpus Christi International Airport
DFW	Dallas - Fort Worth International Airport
ELP	El Paso International Airport
GGG	Longview E TX Rgnl Airport
IAH	Houston Bush Intercontinental
SAT	San Antonio International Airport
VCT	Victoria Regional Airport

Table 64: Summary of Weather Data Assignments for ERCOT Counties

ERCOT COUNTY	ASSIGNED WEATHER STATION
ANDERSON	GGG
ANDREWS	MAF
ANGELINA	GGG
ARANSAS	CRP
ARCHER	SPS
ATASCOSA	SAT
AUSTIN	IAH
BANDERA	SAT
BASTROP	ATT
BAYLOR	SPS
BEE	VCT
BELL	ACT
BEXAR	SAT
BLANCO	ATT
BORDEN	LBB
BOSQUE	ACT
BRAZORIA	IAH
BRAZOS	IAH
BREWSTER	SJT
BRISCOE	AMA
BROOKS	BRO
BROWN	ACT
BURLESON	IAH
BURNET	ATT
CALDWELL	ATT
CALHOUN	VCT
CALLAHAN	ABI
CAMERON	BRO
CHAMBERS	BPT
CHEROKEE	GGG
CHILDRESS	LBB
CLAY	SPS
COKE	SJT
COLEMAN	ABI
COLLIN	DFW
COLORADO	IAH
COMAL	SAT
COMANCHE	ACT
CONCHO	SJT
COOKE	SPS
CORYELL	ACT
COTTLE	SPS
CRANE	MAF
CROCKETT	SJT
CROSBY	LBB
CULBERSON	ELP
DALLAS	DFW
DAWSON	LBB
DE WITT	VCT
DELTA	DFW
DENTON	DFW
DICKENS	LBB
DIMMIT	CRP
DUVAL	CRP
EASTLAND	ABI
ECTOR	MAF
EDWARDS	SJT
ELLIS	DFW
ERATH	ABI
FALLS	ACT
FANNIN	SPS
FAYETTE	IAH
FISHER	ABI
FOARD	SPS
FORT BEND	IAH

ERCOT COUNTY	ASSIGNED WEATHER STATION
FRANKLIN	DFW
FREESTONE	ACT
FRIO	SAT
GALVESTON	IAH
GILLESPIE	ATT
GLASSCOCK	MAF
GOLIAD	VCT
GONZALES	SAT
GRAYSON	SPS
GRIMES	IAH
GUADALUPE	SAT
HALL	AMA
HAMILTON	ACT
HARDEMAN	SPS
HARRIS	IAH
HASKELL	ABI
HAYS	ATT
HENDERSON	DFW
HIDALGO	BRO
HILL	ACT
HOOD	DFW
HOPKINS	DFW
HOUSTON	GGG
HOWARD	MAF
HUDSPETH	ELP
HUNT	SPS
IRION	SJT
JACK	ABI
JACKSON	VCT
JEFF DAVIS	MAF
JIM HOGG	BRO
JIM WELLS	CRP
JOHNSON	DFW
JONES	ABI
KARNES	VCT
KAUFMAN	DFW
KENDALL	SAT
KENEDY	BRO
KENT	LBB
KERR	ATT
KIMBLE	SJT
KING	LBB
KINNEY	SAT
KLEBERG	CRP
KNOX	SPS
LA SALLE	CRP
LAMAR	DFW
LAMPASAS	ACT
LAVACA	VCT
LEE	ATT
LEON	ACT
LIMESTONE	ACT
LIVE OAK	CRP
LLANO	ATT
LOVING	MAF
MADISON	IAH
MARTIN	MAF
MASON	ATT
MATAGORDA	VCT
MAVERICK	CRP
MCCULLOCH	SJT
MCLENNAN	ACT
MCMULLEN	CRP
MEDINA	SAT
MENARD	SJT

ERCOT COUNTY	ASSIGNED WEATHER STATION
MIDLAND	MAF
MILAM	IAH
MILLS	ACT
MITCHELL	ABI
MONTAGUE	SPS
MONTGOMERY	IAH
MOTLEY	LBB
NACOGDOCHES	GGG
NAVARRO	ACT
NOLAN	ABI
NUECES	CRP
PALO PINTO	ABI
PARKER	DFW
PECOS	SJT
PRESIDIO	SJT
RAINS	DFW
REAGAN	MAF
REAL	ATT
RED RIVER	DFW
REEVES	MAF
REFUGIO	VCT
ROBERTSON	IAH
ROCKWALL	DFW
RUNNELS	SJT
RUSK	GGG
SAN PATRICIO	CRP
SAN SABA	ATT
SCHLEICHER	SJT
SCURRY	LBB
SHACKELFORD	ABI
SMITH	DFW
SOMERVELL	DFW
STARR	BRO
STEPHENS	ABI
STERLING	SJT
STONEWALL	LBB
SUTTON	SJT
TARRANT	DFW
TAYLOR	ABI
TERRELL	SJT
THROCKMORTON	ABI
TITUS	DFW
TOM GREEN	SJT
TRAVIS	ATT
UPTON	MAF
UVALDE	SAT
VAL VERDE	SAT
VAN ZANDT	DFW
VICTORIA	VCT
WALLER	IAH
WARD	MAF
WASHINGTON	IAH
WEBB	CRP
WHARTON	VCT
WICHITA	SPS
WILBARGER	SPS
WILLACY	BRO
WILLIAMSON	ATT
WILSON	SAT
WINKLER	MAF
WISE	DFW
YOUNG	ABI
ZAPATA	BRO
ZAVALA	CRP

Table 65: Assignment of NWS Weather Stations for all ERCOT Counties

No.	The City TMY2 Weather File is Available	County with TMY2 Weather Station					Adjacent Counties						Nearest Counties						
		County Name	Weather Zone	HDD	Table	Weather Station Assigned	No.	County Name	Weather Zone	HDD	Table	Weather Station Assigned	No.	County Name	Nearest Cities with TMY2 Files	Weather Zone	HDD	Table	Weather Station Assigned
1	Abilene	TAYLOR	6B	2584	B-8	ABI	1	CALLAHAN	6B			ABI	1	EASTLAND	Abilene (6B)	6B			ABI
							2	COLEMAN	5B			ABI	2	ERATH	Abilene (6B), Fort Worth (5B)	6B			ABI
							3	FISHER	6B			ABI	3	HASKELL	Abilene (6B), Wichita Falls (7B)	6B			ABI
							4	JONES	6B			ABI	4	JACK	Fort Worth (5B), Abilene (6B)	6B			ABI
							5	NOLAN	6B			ABI	5	MITCHELL	Abilene (6B), Midland (6B)	6B			ABI
							6	SHACKELFORD	6B			ABI	6	PALO PINTO	Fort Worth (5B), Abilene (6B)	6B	2625	B-8	ABI
													7	STEPHENS	Abilene (6B)	6B			ABI
													8	THROCKMORTON	Abilene (6B), Wichita Falls (7B)	6B			ABI
													9	YOUNG	Wichita Falls (7B), Abilene (6B), Fort Worth (5B)	6B			ABI
2	Amarillo	POTTER	9B	4258	B-13	AMA							10	BRISCOE	Amarillo (9B), Lubbock (7B)	8			AMA
													11	HALL	Amarillo (9B), Lubbock (7B)	8			AMA
3	Austin	TRAVIS	5B	1688	B-6	ATT	7	BASTROP	4B			ATT	12	GILLESPIE	San Antonio (4B), Austin (5B)	5A			ATT
							8	BLANCO	5A			ATT	13	KERR	San Antonio (4B), Austin (5B)	5A			ATT
							9	BURNET	5A			ATT	14	LEE	Austin (5B), Houston (4B)	4B			ATT
							10	CALDWELL	4B			ATT	15	LLANO	Austin (5B), San Antonio (4B),	5B			ATT
							11	HAYS	5B			ATT	16	MASON	Austin (5B), San Antonio (4B),	5B			ATT
							12	WILLIAMSON	5B			ATT	17	REAL	San Antonio (4B), Austin (5B), San Angelo (5B)	5A			ATT
													18	SAN SABA	Austin (5B), San Angelo (5B), Waco (5B)	5B			ATT
4	Brownsville	CAMERON	2B	635	B-3	BRO	13	HIDALGO	2B	778	B-3	BRO	19	BROOKS	Brownsville (2B), Corpus Christie (3B)	2B			BRO
							14	WILLACY	2B			BRO	20	JIM HOGG	Brownsville (2B), Corpus Christie (3B)	2B			BRO
													21	KENEDY	Brownsville (2B), Corpus Christie (3B)	2B			BRO
													22	STARR	Brownsville (2B)	2B			BRO
													23	ZAPATA	Brownsville (2B), Corpus Christie (3B)	2B			BRO
5	Corpus Christi	NUECES	3B	1016	B-5	CRP	15	ARANSAS	3B			CRP	24	DIMMIT	Corpus Christi (3B), San Anotonio (4B)	3C			CRP
							16	JIM WELLS	3C	1062	B-5	CRP	25	DUVAL	Corpus Christi (3B)	3C			CRP
							17	KLEBERG	2B			CRP	26	LA SALLE	Corpus Christi (3B)	3C			CRP
							18	SAN PATRICIO	3C			CRP	27	LIVE OAK	Corpus Christi (3B), Victoria (3B)	3C			CRP
													28	MAVERICK	San Anotonio (4B), Corpus Christi (3B)	3C	1441	B-5	CRP
													29	MCMULLEN	Corpus Christi (3B), Victoria (3B)	3C			CRP
													30	WEBB	Corpus Christi (3B)	3C	1025	B-5	CRP
													31	ZAVALA	San Anotonio (4B), Corpus Christi (3B)	3C			CRP
6	El Paso	EL PASO	6B	2708	B-10	ELP	19	HUDSPETH	6B			ELP	32	CULBERSON	El Paso (6B)	6B			ELP
7	Fort Worth	TARRANT	5B	2304	B-8	DFW	20	COLLIN	6B			DFW	33	DELTA	Fort Worth (5B)	6B			DFW
							21	DALLAS	5B	2259	B-8	DFW	34	FRANKLIN	Fort Worth (5B)	6B			DFW
							22	DENTON	6B	2665	B-8	DFW	35	HENDERSON	Fort Worth (5B), Lufkin (5A), Waco (5B)	5B			DFW
							23	ELLIS	5B			DFW	36	HOOD	Fort Worth (5B), Waco (5B)	5B			DFW
							24	JOHNSON	5B			DFW	37	HOPKINS	Fort Worth (5B)	6B			DFW
							25	PARKER	6B			DFW	38	KAUFMAN	Fort Worth (5B)	6B			DFW
							26	WISE	6B			DFW	39	LAMAR	Fort Worth (5B)	6B			DFW
													40	RAINS	Fort Worth (5B)	6B			DFW
													41	RED RIVER	Fort Worth (5B)	6B			DFW
													42	ROCKWALL	Fort Worth (5B)	6B			DFW
													43	SMITH	Fort Worth (5B), Lufkin (5A)	5B	2194	B-8	DFW
													44	SOMERVELL	Fort Worth (5B), Waco (5B)	5B			DFW
													45	TITUS	Fort Worth (5B)	6B			DFW
													46	VAN ZANDT	Fort Worth (5B)	6B			DFW
8	Houston	HARRIS	4B	1371	B-5	IAH	27	BRAZORIA	3B			IAH	47	AUSTIN	Houston (4B)	4B			IAH
							28	FORT BEND	4B			IAH	48	BRAZOS	Houston (4B), Austin (5B), Waco (5B)	4B			IAH
							29	GALVESTON	3B	1263	B-5	IAH	49	BURLESON	Austin (5B), Waco (5B), Houston (4B)	4B			IAH
							30	MONTGOMERY	4B			IAH	50	COLORADO	Houston (4B), Victoria (3B)	4B			IAH
							31	WALLER	4B			IAH	51	FAYETTE	Houston (4B), San Antonio (4B)	4B			IAH
													52	GRIMES	Houston (4B)	4B			IAH
													53	MADISON	Houston (4B), Waco (5B), Lufkin (5A)	4B			IAH
													54	MILAM	Austin (5B), Waco (5B), Houston (4B)	4B			IAH
													55	ROBERTSON	Waco (5B), Houston (4B)	4B			IAH
													56	WASHINGTON	Houston (4B), Austin (5B)	4B			IAH
9	Lubbock	LUBBOCK	7B	3431	B-11	LBB	32	CROSBY	7B			LBB	57	BORDEN	Lubbock (7B), Abilene (6B), Midland (6B)	7B			LBB
													58	CHILDRESS	Lubbock (7B), Wichita Falls (7B)	7B			LBB
													59	DAWSON	Lubbock (7B), Midland (6B)	7B	3159	B-11	LBB
													60	DICKENS	Lubbock (7B)	7B			LBB
													61	KENT	Lubbock (7B), Abilene (6B)	7B			LBB
													62	KING	Lubbock (7B), Abilene (6B), Wichita Falls (7B)	7B			LBB
													63	MOTLEY	Lubbock (7B)	7B			LBB
													64	SCURRY	Lubbock (7B), Midland (6B), Abilene (6B)	7B	3185	B-11	LBB
													65	STONEWALL	Abilene (6B), Lubbock (7B), Wichita Falls (7B)	7B			LBB
10	Lufkin	ANGELINA	5A	1951	B-8	GGG	33	CHEROKEE	5A			GGG	66	ANDERSON	Lufkin (5A)	5A	2005	B-8	GGG
							34	HOUSTON	5A			GGG	67	RUSK	Lufkin (5A)	5B			GGG
							35	NACOGDOCHES	5A			GGG	67						
11	Midland	MIDLAND	6B	2751	B-10	MAF	36	ANDREWS	6B			MAF	68	HOWARD	Midland (6B)	6B	2772	B-10	MAF
							37	CRANE	5B			MAF	69	JEFF DAVIS	Midland (6B), El Paso (6B)	6B			MAF
							38	ECTOR	6B			MAF	70	LOVING	Midland (6B)	6B			MAF
							39	GLASSCOCK	6B			MAF	71	REEVES	Midland (6B)	6B	2505	B-8	MAF
							40	MARTIN	6B			MAF	72	WARD	Midland (6B)	6B			MAF
							41	REAGAN	5B			MAF	73	WINKLER	Midland (6B)	6B			MAF
							42	UPTON	5B			MAF	73						
12	Port Arthur	JEFFERSON	4B	1677	B-6	BPT	43	CHAMBERS	4B			BPT	73						
13	San Angelo	TOM GREEN	5B	2414	B-8	SJT	44	COKE	6B			SJT	74	BREWSTER	El Paso (6B), San Angelo (5B)	5A			SJT
							45	CONCHO	5B			SJT	75	CROCKETT	San Angelo (5B)	5B			SJT
							46	IRION	5B			SJT	76	EDWARDS	San Angelo (5B)	5A			SJT
							47	MENARD	5B			SJT	77	KIMBLE	San Angelo (5B), Austin (5B)	5A			SJT
							48	RUNNELS	5B			SJT	78	MCCULLOCH	San Angelo (5B)	5B			SJT
							49	SCHLEICHER	5B			SJT	79	PECOS	San Angelo (5B)	5A			SJT
							50	STERLING	6B			SJT	80	PRESIDIO	El Paso (6B), San Angelo (5B)	5A			SJT
													81	SUTTON	San Angelo (5B)	5A			SJT
													82	TERRELL	San Angelo (5B)	5A			SJT
14	San Antonio	BEXAR	4B	1644	B-6	SAT	51	ATASCOSA	3C			SAT	83	FRIO	San Antonio (4B), Corpus Christi (3B)	3C			SAT
							52	BANDERA	5A			SAT	84	GONZALES	San Antonio (4B), Victoria (3B)	4B			SAT
							53	COMAL	4B			SAT	85	KINNEY	San Antonio (4B)	4B			SAT
							54	GUADALUPE	4B			SAT	86	UVALDE	San Antonio (4B)	4B			SAT
							55	KENDALL	5A			SAT	87	VAL VERDE	San Anotonio (4B), San Angelo (5B)	4B	1565	B-5	SAT
							56	MEDINA	4B			SAT	87						SAT
							57	WILSON	4B			SAT	87						
15	Victoria	VICTORIA	3B	1296	B-5	VCT	58	CALHOUN	3B			VCT	88	BEE	Corpus Christi (3B), Victoria (3B)	3B	1372	B-5	VCT
							59	DE WITT	3C			VCT	89	KARNES	Victoria (3B), San Antonio (4B), Corpus Christi (3B)	3C			VCT
							60	GOLIAD	3B			VCT	90	MATAGORDA	Victoria (3B)	3B	1370	B-5	VCT
							61	JACKSON	3B			VCT	91	WHARTON	Victoria (3B), Houston (4B)	3B			VCT
							62	LAVACA	4B			VCT	91						
							63	REFUGIO	3B			VCT	91						
16	Waco	MCLENNAN	5B	2179	B-8	ACT	64	BELL	5B	2127	B-8	ACT	92	BROWN	Abilene (6B), Waco (5B), San Angelo (5B)	5B	2199	B-8	ACT
							65	BOSQUE	5B			ACT	93	COMANCHE	Waco (5B), Abilene (6B)	5B			ACT
							66	CORYELL	5B			ACT	94	FREESTONE	Waco (5B)	5B			ACT
							67	FALLS	5B			ACT	95	HAMILTON	Waco (5B)	5B			ACT
							68	HILL	5B			ACT	96	LAMPASAS	Waco (5B), Austin (5B)	5B			ACT
							69	LIMESTONE	5B			ACT	97	LEON	Waco (5B), Lufkin (5A)	5B			ACT
													98	MILLS	Waco (5B), Austin (5B)	5B			ACT
													99	NAVARRO	Waco (5B), Fort Worth (5B)	5B	2396	B-8	ACT
17	Wichita Falls	WICHITA	7B	3042	B-10	SPS	70	ARCHER	7B			SPS	100	COOKE	Fort Worth (5B), Wichita Falls (7B)	6B			SPS
							71	BAYLOR	7B			SPS	101	COTTLE	Witchita Falls (7B), Lubbock (7B)	7B			SPS
							72	CLAY	7B			SPS	102	FANNIN	Fort Worth (5B), Wichita Falls (7B)	6B			SPS
							73	WILBARGER	7B	3186	B-10	SPS	103	FOARD	Witchita Falls (7B)	7B			SPS
													104	GRAYSON	Fort Worth (5B), Wichita Falls (7B)	6B	2890	B-10	SPS
													105	HARDEMAN	Witchita Falls (7B)	7B			SPS
													106	HUNT	Fort Worth (5B), Wichita Falls (7B)	6B	2953	B-10	SPS
													107	KNOX	Wichita Falls (7B)	7B			SPS
													108	MONTAGUE	Wichita Falls (7B), Fort Worth (5B)	6B			SPS

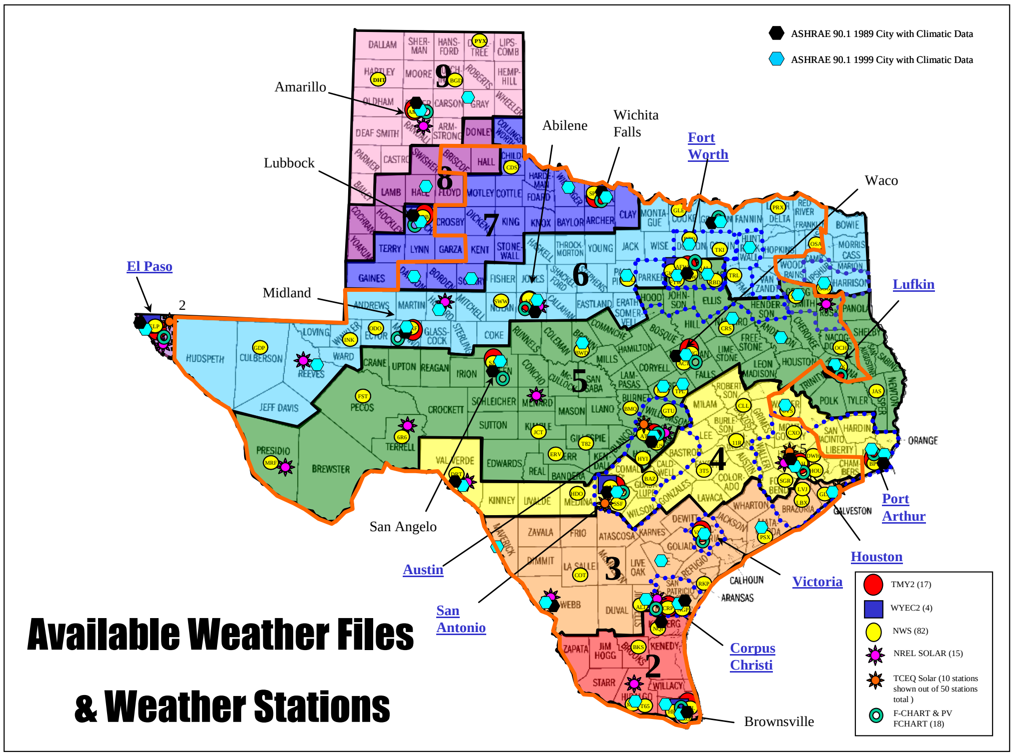

Figure 107: Available Weather Stations in Texas for all ERCOT Counties

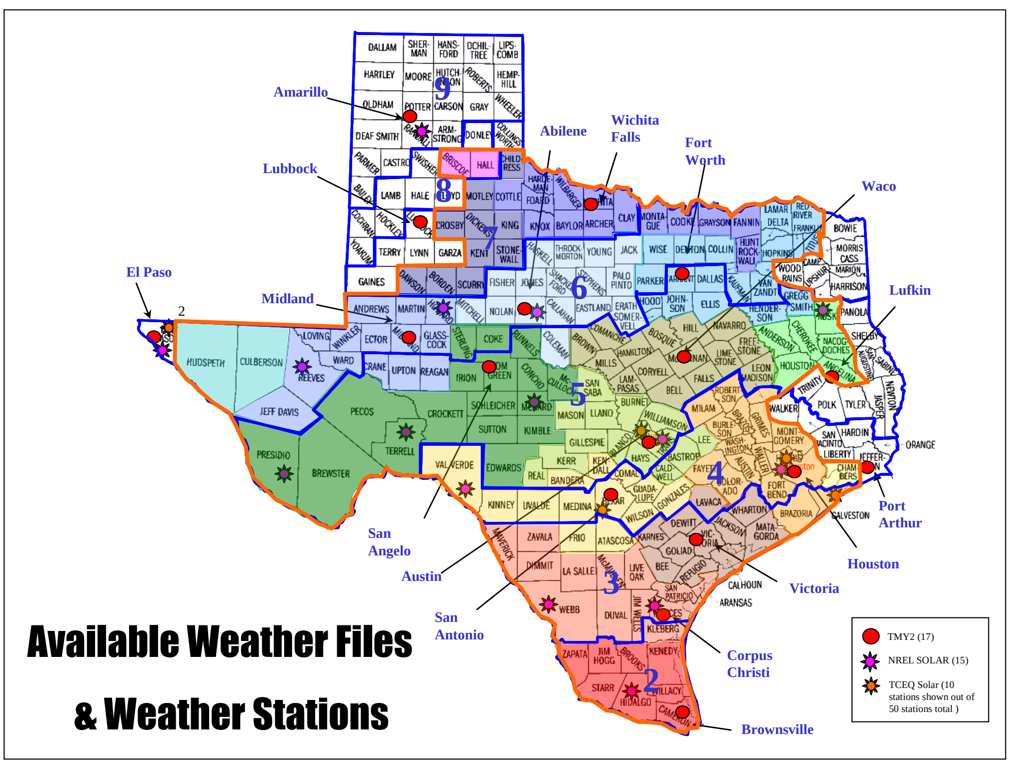

Figure 108: Grouping of Weather Stations in Texas for all ERCOT Counties

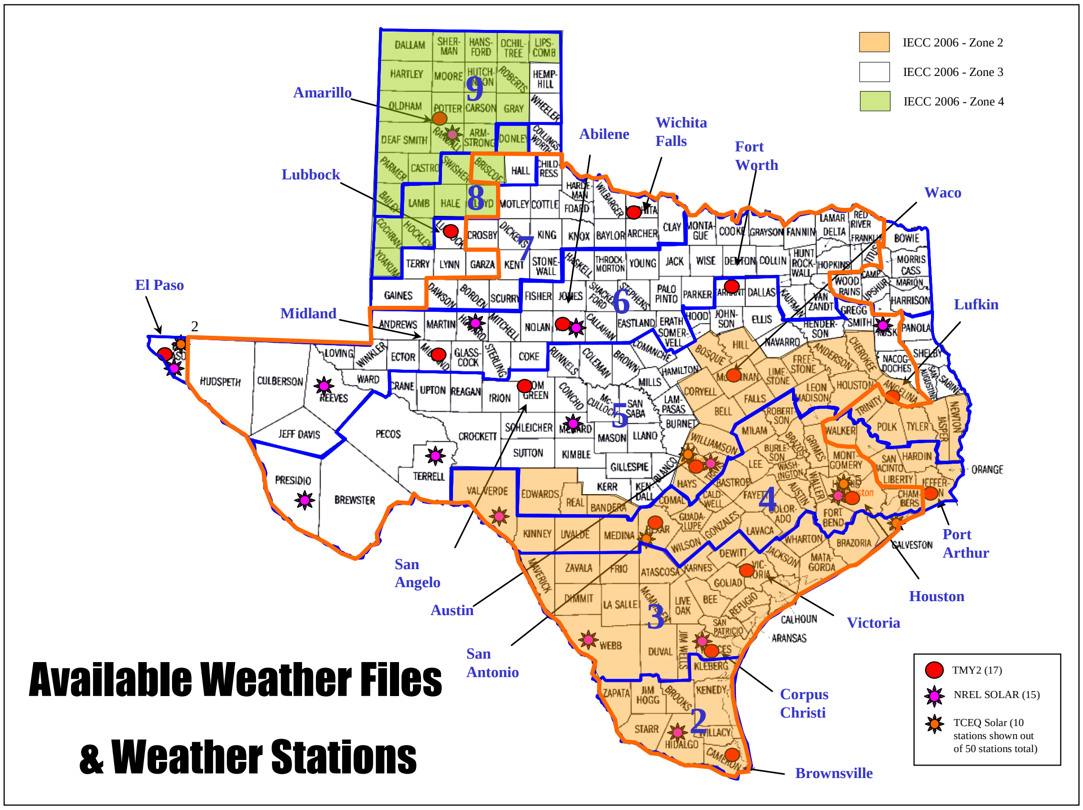

Figure 109: Available Weather Stations in Texas for all ERCOT Counties Showing 2000/2001 and 2006 Climate Zones

List of Available Weather Files and Weather Stations of Texas

Texas Weather Stations (NOAA)

1	Abilene Regional Airport (ABI)
2	Alice International Airport (ALI)
3	Amarillo International Airport (AMA)
4	Angleton / Lake Jackson Brazori (LBX)
5	Arlington Municipal Airport (GKY)
6	Austin - Bergstrom International (AUS)
7	Austin Camp Mabry (ATT)
8	Borger Hutchinson County Airport (BGD)
9	BRENHAM: BRENHAM MUNICIPAL AIRPORT (11R)
10	Brownsville S Padre Isl International (BRO)
11	BROWNWOOD: BROWNWOOD REGIONAL AIRPORT (BWD)
12	Burnet Municipal Airport (BMQ)
13	Childress Municipal Airport (CDS)
14	College Station (CLL)
15	Conroe Montgomery County Airport (CXO)
16	Corpus Christi International Airport (CRP)
17	CORPUS CHRISTI: CORPUS CHRISTI NAS/TRUAX FIELD ARPT (NGP)
18	Corsicana Campbell Field (CRS)
19	Cotulla La Salle Co Airport (COT)
20	Dalhart Municipal Airport (DHT)
21	Dallas - Fort Worth International Airport (DFW)
22	Dallas Love Field (DAL)
23	Dallas Redbird Airport (RBD)
24	Del Rio International Airport (DRT)
25	Denton Municipal Airport (DTO)
26	Dryden Terrell County Airport (6R6)
27	El Paso International Airport (ELP)
28	FALFURRIAS : BROOKS COUNTY AIRPORT (BKS)
29	Fort Stockton Pecos County Airport (FST)
30	Fort Worth Alliance Airport (AFW)
31	Fort Worth Meacham (FTW)
32	FREDERICKSBURG: GILLESPIE COUNTY AIRPORT (T82)
33	GAINESVILLE : GAINESVILLE MUNICIPAL AIRPORT (GLE)
34	Galveston Scholes Field (GLS)
35	GEORGETOWN : GEORGETOWN MUNICIPAL AIRPORT (GTU)
36	Harlingen Rio Grande Valley I (HRL)
37	Hondo Municipal Airport (HDO)
38	Houston Bush Intercontinental (IAH)
39	Houston Clover Field (LVJ)
40	Houston Hooks Memorial Airport (DWH)
41	Houston Sugarland Mem (SGR)
42	Houston William P Hobby Airport (HOU)
43	Huntsville Municipal Airport (UTS)
44	JASPER : JASPER COUNTY-BELL FIELD AIRPORT (JAS)
45	Junction Kimble County Airport (JCT)
46	KERRVILLE : KERRVILLE MUNI/LOUIS SCHREINER FLD AIRPORT (ERV)
47	KILLEEN : KILLEEN MUNICIPAL AIRPORT (ILE)
48	KINGSVILLE : KINGSVILLE NAS AIRPORT (NQI)
49	LA GRANGE : FAYETTE REGIONAL AIR CENTER AIRPORT (3T5)
50	Longview E Tx Rgnl Airport (GGG)
51	Lubbock International Airport (LBB)
52	Lufkin Angelina Cty Airport (LFK)
53	MARFA : MARFA MUNICIPAL AIRPORT (MRF)
54	McAllen Miller International Airport (MFE)
55	McKinney Municipal Airport (TKI)
56	Midland International Airport (MAF)
57	Mineral Wells Airport (MWL)
58	MOUNT PLEASANT : MOUNT PLEASANT REGIONAL AIRPORT (OSA)
59	NACOGDOCHES : A L MANGHAM JR REGIONAL AIRPORT (OCH)
60	New Braunfels Municipal Airport (BAZ)
61	Odessa Schlemeyer Field (ODO)
62	Palacios Municipal Airport (PSX)
63	PARIS : COX FIELD AIRPORT (PRX)
64	PERRYTON : PERRYTON OCHILTREE COUNTY AIRPORT (PYX)
65	Pine Springs Guadalupe Mounta (GDP)
66	Port Arthur Se Tx Rgnl Airport (BPT)
67	Port Isabel Cameron County Airport (PIL)
68	Rockport Aransas Co Airport (RKP)
69	San Angelo Mathis Field (SJT)
70	San Antonio International Airport (SAT)
71	San Antonio Stinson Municipal Airport (SSF)
72	SAN MARCOS : SAN MARCOS MUNICIPAL AIRPORT (HYI)
73	SWEETWATER : AVENGER FIELD AIRPORT (SWW)
74	TEMPLE: DRAUGHON-MILLER CNTRL TEXAS REGIONAL ARPT (TPL)
75	Terrell Municipal Airport (TRL)
76	Tyler Pounds Field (TYR)
77	Victoria Regional Airport (VCT)
78	WACO : MC GREGOR EXECUTIVE AIRPORT (PWG)
79	Waco Regional Airport (ACT)
80	WESLACO : MID VALLEY AIRPORT (T65)
81	Wichita Falls Municipal Airport (SPS)
82	Wink Winkler Co Airport (INK)

Texas TMY2 Weather Files

1	Abilene
2	Amarillo
3	Austin
4	Brownsville
5	Corpus Christi
6	El Paso
7	Fort Worth
8	Houston
9	Lubbock
10	Lufkin
11	Midland
12	Port Arthur
13	San Angelo
14	San Antonio
15	Victoria
16	Waco
17	Wichita Falls

Texas WYEC2 Weather Files

1	El Paso
2	Brownsville
3	Fort Worth
4	San Antonio

NREL Solar Stations

1	Abilene
2	Austin
3	Big Spring
4	Canyon
5	Clear Lake
6	Corpus Christi
7	Del Rio
8	Edinburg
9	El Paso
10	Laredo
11	Menard
12	Overton
13	Pecos
14	Presidio
15	Sanderson

TCEQ Solar Stations

1	Bexar
2	Travis
3	El Paso (2)
4	Galveston
5	Harris (5)

FCHART and PV FCHART (New Weather File)

1	ABILENE
2	AMARILLO
3	AUSTIN
4	BROWNSVILLE
5	CORPUS CHRISTI
6	EL PASO
7	FORT WORTH
8	HOUSTON
9	LUBBOCK
10	LUFKIN
11	MIDLAND-ODESSA
12	PORT ARTHUR
13	SAN ANGELO
14	SAN ANTONIO
15	SHERMAN
16	VICTORIA
17	WACO
18	WICHITA FALLS

Figure 110: List of Available Weather Files in Texas (Listed by Symbol)

9 Regional Energy Baselines and Measurement and Verification Protocols

9.1 Summary

This report presents deliverables developed and documented by the Energy Systems Laboratory (ESL) for use by the 12 southern state region including Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Caroline, Tennessee, Texas and Virginia.

The primary goal of this subtask is to provide the state energy offices with a comparison tool for energy use either by total or per capita. This tool is expected to allow the state energy offices to compare their energy use pattern against other states' and the national average energy use by end-use sector. In addition, they can use this tool for a comparison of energy use within their states by end-use and by fuel-source. Another goal of this subtask is to demonstrate the usability of publicly available data such as the U.S. DOE EIA data sets and the U.S. Census Bureau data sets. This approach has been successfully demonstrated by ESL as part of the Comptroller of Public Accounts and the State Energy Conservation Office report on Texas Energy Future.

To define the baseline energy patterns within the southern 12-state region (Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia), the raw data was downloaded from the following websites: the U.S. DOE EIA website[64] and the U.S. Census Bureau website[65].

This report consists of four parts:

- Energy use per capita ranked by state for 2006 (latest year data available);
- Historical energy use per capita for the southern 12-state during 1960-2006;
- Energy use and energy use per capita by end-use sector and fuel source during 1960-2006 for the U.S. and Texas; and
- Recommended measurement and verification (M&V) protocols - ASHRAE/CIBSE/USGBC Performance Measurement Protocols (PMP) for Commercial Buildings.

Limited preliminary analysis of the data was made since it was not a project goal. The data provides the basis by which extensive state-by-state analysis can begin. In addition, the recommended measurement and verification (M&V) protocols for an individual building or facility, ASHRAE/CIBSE/USGBC Performance Measurement Protocols (PMP) for Commercial Buildings, can be used as a bottom-up approach for energy efficiency improvements of buildings within the southern 12-state region.

9.2 Overview

This section covers the energy use per capita of the 50 states and the District of Columbia for the year of 2006. This includes total energy use per capita (Figure 111) and energy use per capita by end-use sector (Figure 112 to Figure 117): electric power, residential, commercial, residential plus commercial, transportation, and industrial sector. Two different scales were selected and used to display data for the purpose of comparison: 1,200 million Btu for the charts of total and electric power sector and 600 million Btu for the charts of the other sectors: residential, commercial, residential plus commercial, transportation, and industrial sector.

Each state's energy use per capita is ranked by state with the U.S. average energy use per capita. The green bar indicates the U.S. average energy use per capita and is displayed with a dotted green line for a better comparison. The twelve red bars indicate each of southern 12-state's energy use per capita while the 39 blue bars represent the other 38 states and the District of Columbia.

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[64] U.S. DOE, EIA. 2008. *Consumption, Price, and Expenditure Estimates through 2006: Complete Data Files, All States and All Years*, State Energy Data System (SEDS), Energy Information Administration, U.S. Department of Energy, Retrieved from http://www.eia.doe.gov/emeu/states/_seds.html (accessed February 2, 2009).

[65] U.S. Census Bureau. 2008. *Annual Population Estimates 2000 to 2008: Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2008*, National and State Population Estimates, U.S. Census Bureau, Retrieved from http://www.census.gov/popest/states/NST-ann-est.html (accessed February 2, 2009).

9.3 Total Energy Use per Capita, Ranked by State (2006)

Figure 111 shows the total energy use per capita of the 50 states and the District of Columbia for the year of 2006. The U.S. average was 334 million Btu per capita.

Alaska had the highest total energy use per capita for 2006 with 1,114 million Btu, whereas New York State had the lowest value with 203 million Btu. Alaska's high energy intensity is primarily due to its high transportation and industrial energy consumption. This could be partially explained with the fact that the dominant industry in the Alaskan economy is oil and gas and it has a low population density. On the contrary, New York State's low energy intensity can be explained with its high population density. Wyoming, Louisiana, and North Dakota also have a distinctive high energy use pattern: these states use about 3 to 5 times more energy per capita than the low energy-intensive states. This could be due to their high transportation and industrial energy consumption and the low population density of Wyoming and North Dakota.

Among the southern 12-states, Louisiana ranked the highest with 896 million Btu per capita while Florida ranked last with 256 million Btu per capita. The second highest was Texas with 503 million Btu per capita, and the second lowest was North Carolina with 301 million Btu per capita. The high rank of Louisiana and Texas is mainly due to their high industrial energy consumption. Louisiana ranked the highest in industrial energy use per capita with 570 million Btu which occupies 64% of total energy use per capita. Texas ranked in fifth place with 254 million Btu that represents 50% of total energy use per capita.

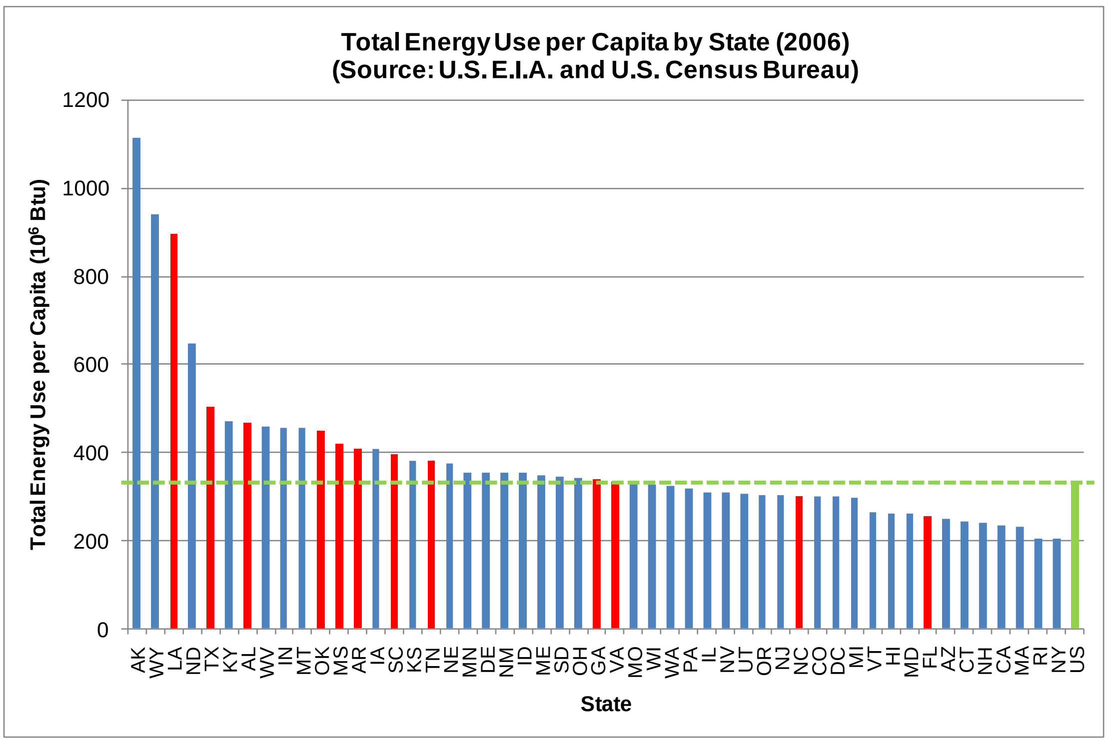


Figure 111: Total Energy Use per Capita, Ranked by State, 2006

9.4 Electric Power Energy Use per Capita, Ranked by State (2006)

Figure 112 shows the electric power energy use per capita of the 50 states and the District of Columbia for the year 2006. The electric power energy use consists of the energy consumed by facilities to generate, transmit, and distribute electric energy. The U.S. average was 133 million Btu per capita.

Wyoming had the highest electric power energy use per capita for 2006 with 921 million Btu, whereas the District of Columbia had the lowest value with 2.3 million Btu. Wyoming's high electric power energy use, in spite of the fact that it has the lowest population density in the U.S., could be due to the massive power facilities in Wyoming that provide electricity to the western United States. On the contrary, the District of Columbia showed abnormally low electric power energy intensity because D.C. relies on imported electricity from the surrounding states. It should be noted that the amount of electricity produced in the state is sometimes different from the amount consumed by the state. North Dakota and West Virginia, as interstate exporters of electricity, also showed distinctively high electric power energy intensity—about four times more energy per capita than the U.S. average. Electric use per capita in each state warrants closer investigation into how it is reported to EIA with USDOE.

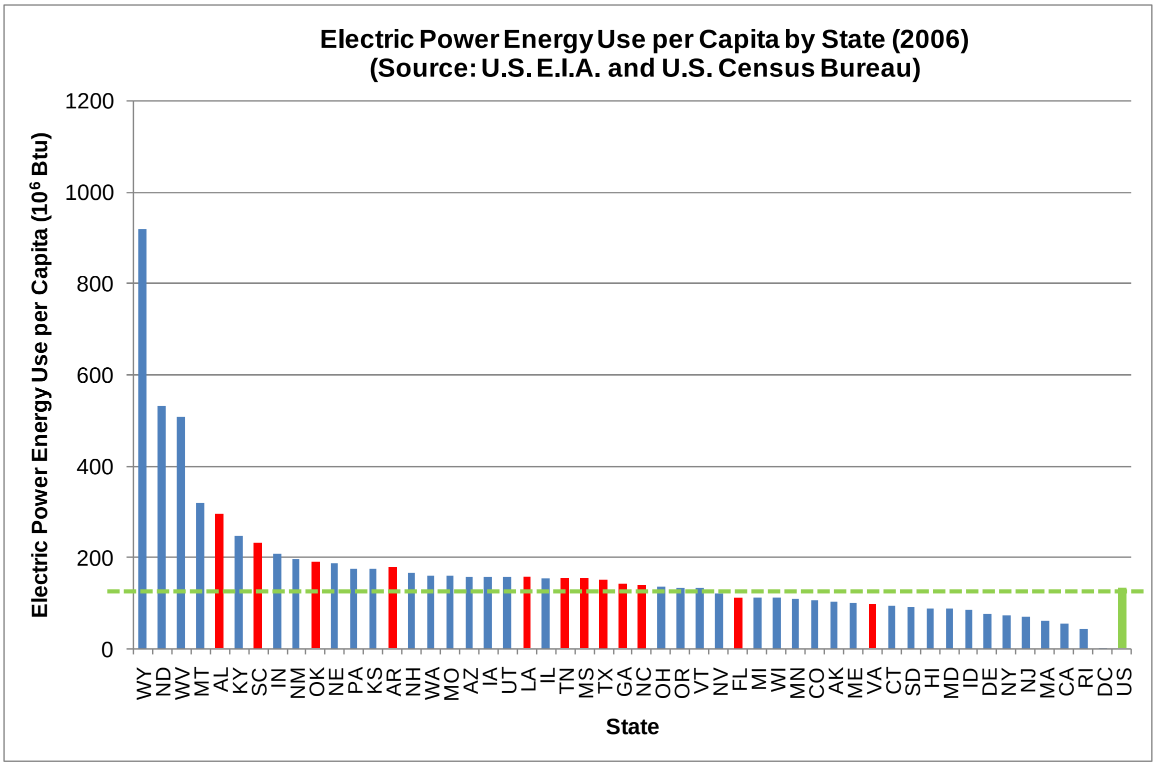


Figure 112: Energy Use per Capita by the Electric Power Sector, Ranked by State, 2006

9.5 Residential and Commercial Energy Use per Capita, Ranked by State (2006)

Figure 113 and Figure 114, respectively, show the residential and commercial energy use per capita of the 50 states and the District of Columbia for the year 2006. Figure 115 shows the combined residential and commercial per capita energy use that can be seen as the entire building sector's per capita energy use. The commercial energy use consists of the energy consumed by many different building types. These include businesses, institutions, and organizations that provide services.

The U.S. average was 70 million Btu per capita for the residential sector and 59 million Btu per capita for the commercial sector. For both residential and commercial building sectors, the variation between states was relatively small compared with other end-use sectors.

For the commercial buildings sector, the variation between states was relatively small except four top-ranking states which include Washington D.C., Wyoming, Alaska, and North Dakota and the two low-ranking states of California and Hawaii. A similar pattern was found in the combined residential and commercial per capita energy use. It is worth noting that California had far less combined residential and commercial per capita use than the other states and the U.S. average. This could be partly because of their mild climate and partly because of their early adoption of various energy policies and incentives.

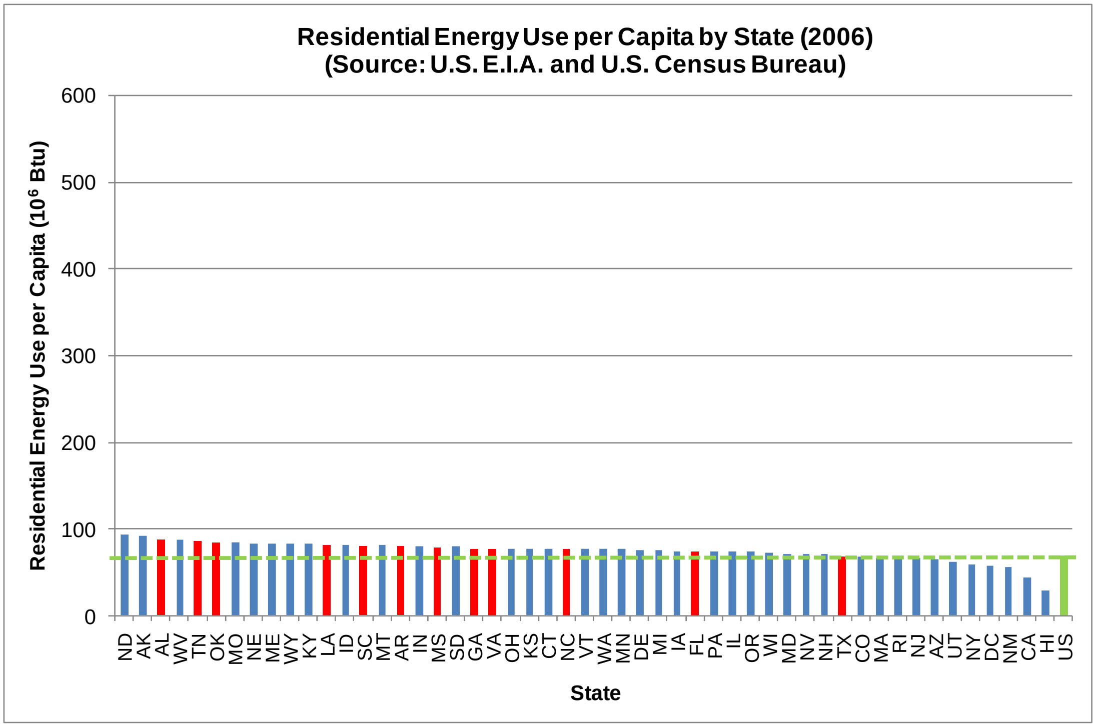


Figure 113: Energy Use per Capita by the Residential Sector, Ranked by State, 2006

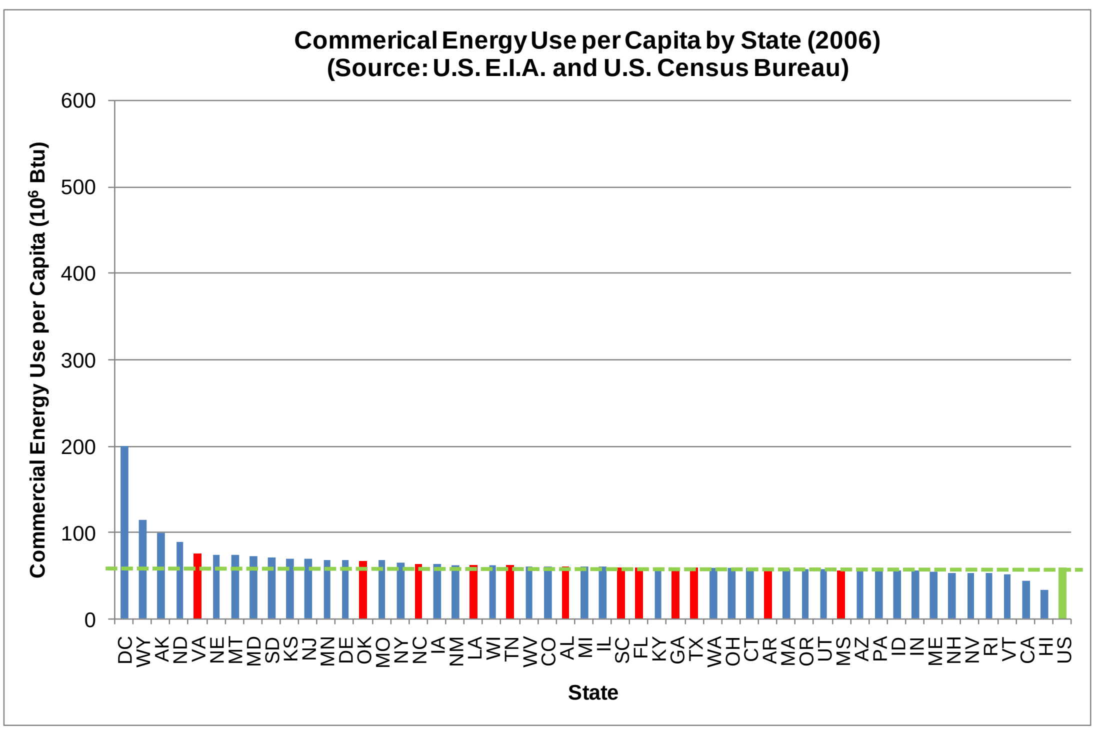


Figure 114: Energy Use per Capita by the Commercial Sector, Ranked by State, 2006

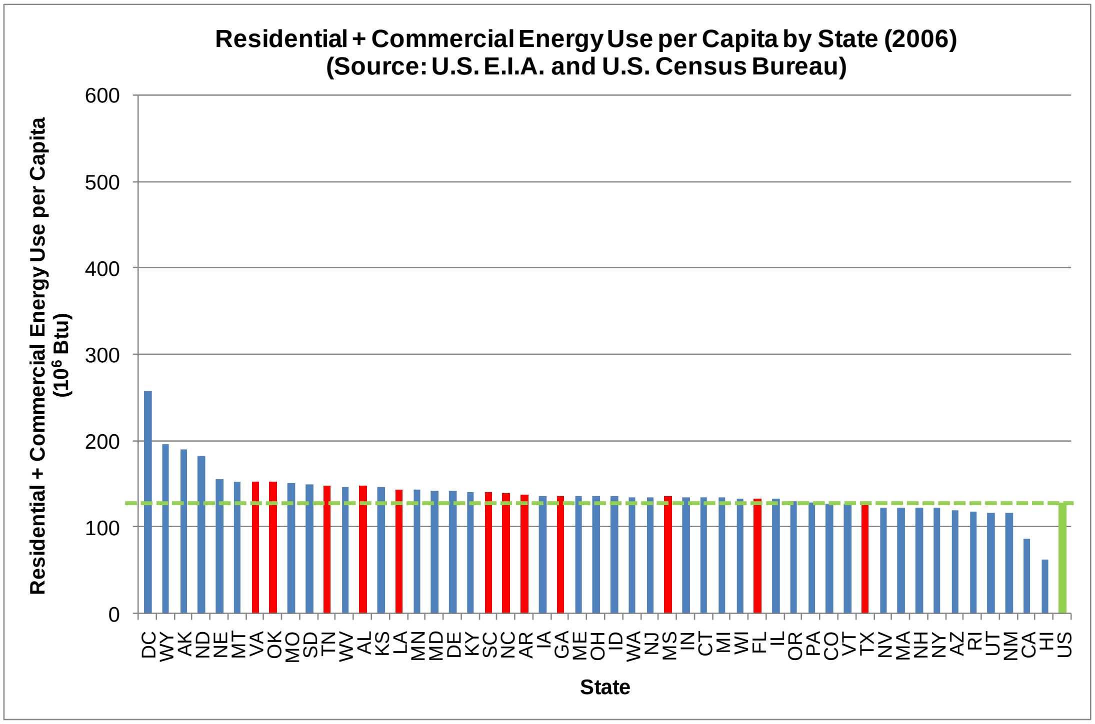


Figure 115: Energy Use per Capita by the Residential and Commercial Sector, Ranked by State, 2006

9.6 Transportation Energy Use per Capita, Ranked by State (2006)

Figure 116 shows the transportation energy use per capita of the 50 states and the District of Columbia for the year 2006. The U.S. average was 97 million Btu per capita.

Alaska had the highest transportation energy use per capita for 2006 with 393 million Btu, whereas the District of Columbia had the lowest value with 36 million Btu. Alaska's high transportation energy intensity may be partly because of its high aviation fuel consumption and its high industrial energy consumption. Similarly, the District of Columbia's very low transportation energy intensity can be explained with its high availability and usage of public transportation. A similar result can be found in New York which ranked in the second lowest place due to its public transportation.

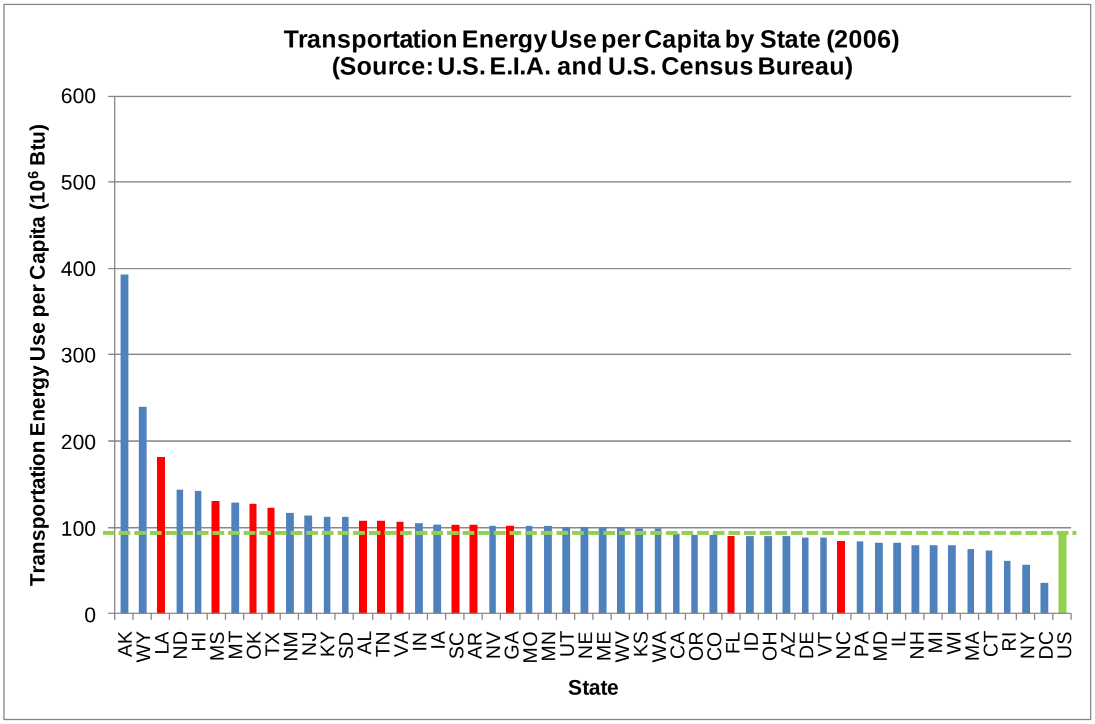


Figure 116: Energy Use per Capita by the Transportation Sector, Ranked by State, 2006

9.7 Industrial Energy Use per Capita, Ranked by State (2006)

Figure 117 shows the industrial energy use per capita of the 50 states and the District of Columbia for the year 2006. The U.S. average was 108 million Btu per capita.

The variation of industrial energy intensity between states was very high compared with other end-use sectors. Louisiana had the highest industrial energy use per capita for 2006 with 570 million Btu, whereas the District of Columbia had the lowest value with 6.1 million Btu. Alaska, Wyoming, North Dakota and Texas also showed distinctively high industrial energy intensity, more than twice the U.S. average.

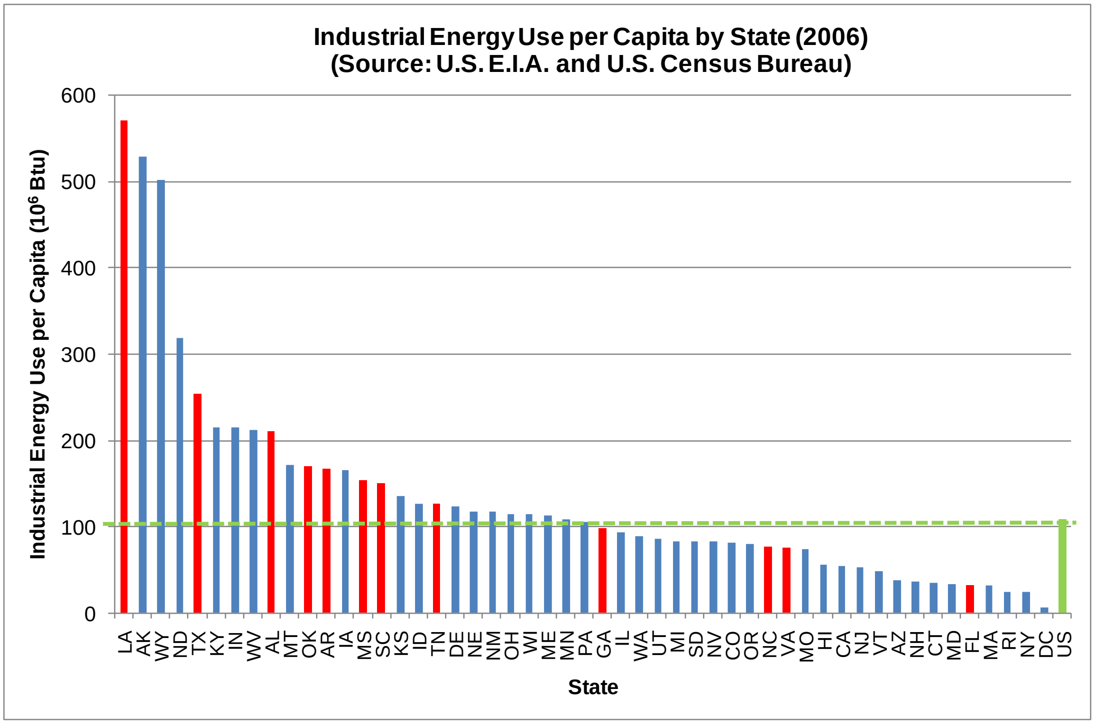


Figure 117: Energy Use per Capita by the Industrial Sector, Ranked by State, 2006

9.8 Historical Energy Use per Capita for the 12 Southern States during 1960-2006

9.8.1 Overview

This section covers the historical energy use per capita of the southern 12-states during the years of 1960 through 2006. This includes total energy use per capita (Figure 118) and energy use per capita by end-use sector (Figure 119 to Figure 124): electric power, residential, commercial, residential plus commercial, transportation, and industrial sector. Two different scales were selected and used to display data for the purpose of a comparison. The following scales were used: 1,200 million Btu for the charts of total and industrial sectors and 300 million Btu for the charts of other sectors, including residential, commercial, residential plus commercial, transportation, and electric power sector.

Each state's energy use per capita is displayed with the U.S. average energy use per capita. The red line indicates the U.S. average energy use per capita. The other 12 lines indicate the historical energy use pattern of each of the southern 12-states—Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

9.8.2 Total Energy Use per Capita for the Southern 12-States during 1960-2006

Figure 118 shows the total energy use per capita of the southern 12-states during the period of 1960 through 2006. Louisiana ranked the highest; the second highest was Texas. This is mainly due to their high industrial energy use per capita. It is noteworthy that Texas' total energy use per capita has decreased since 2000, while Louisiana's energy consumption pattern is fluctuating. Florida ranked the lowest. Since the middle of the 1970s, Florida's energy use pattern remained almost flat at around 250 million Btu per capita which was less than the U.S. average. Except for the aforementioned three states, the per capita energy use patterns of the other nine states were tightly grouped.

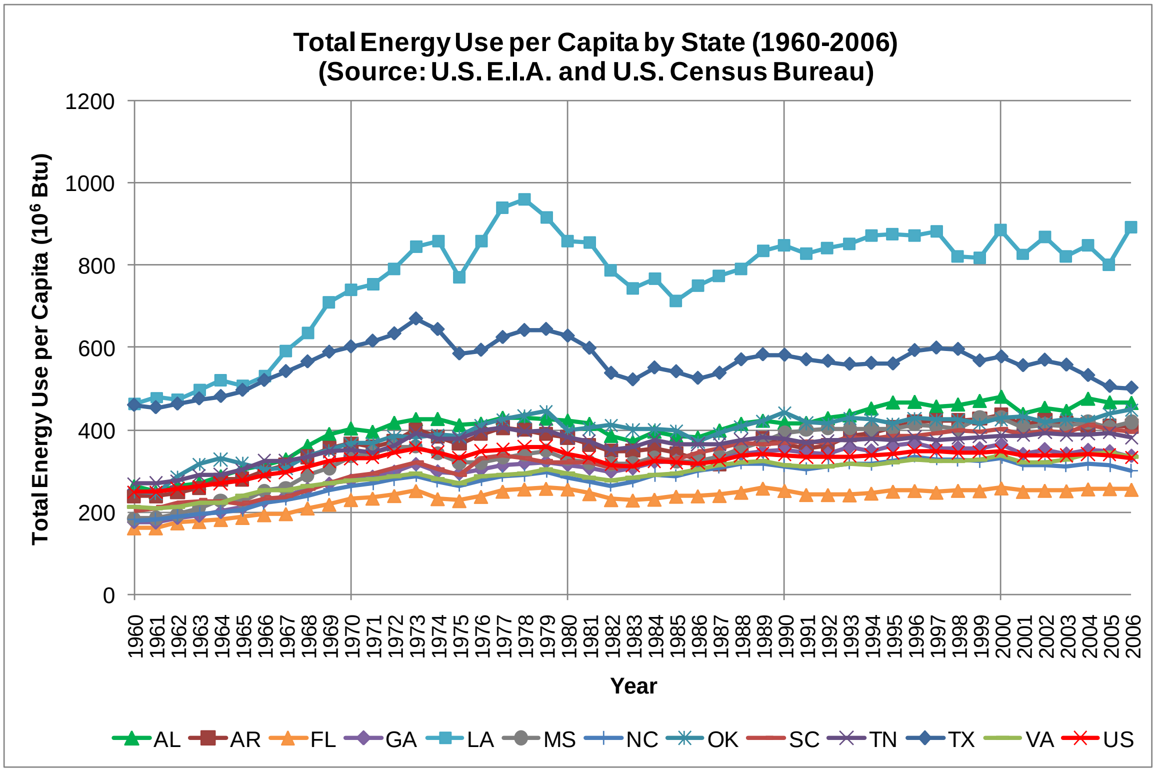


Figure 118: Total Energy Use per Capita, for the 12 Southern States during 1960-2006

9.8.3 Industrial Energy Use per Capita for the 12 Southern States during 1960-2006

Figure 119 shows the industrial energy use per capita of Texas, compared to eleven Southern states during the period of 1960 through 2006. The historical per capita industrial energy use pattern has parallels with the total energy use per capita addressed in the previous section. Louisiana ranked the highest, while the second highest was Texas. It is evident that that Texas' industrial energy use per capita has been decreasing since 2000—while Louisiana's industrial energy consumption pattern is fluctuating. Florida ranked the lowest, and since the 1980s, their industrial energy use pattern remained almost flat at around 40 million Btu per capita which is much less than the U.S. average. Except for the aforementioned three states, the per capita industrial energy use patterns of the other nine states were tightly grouped.

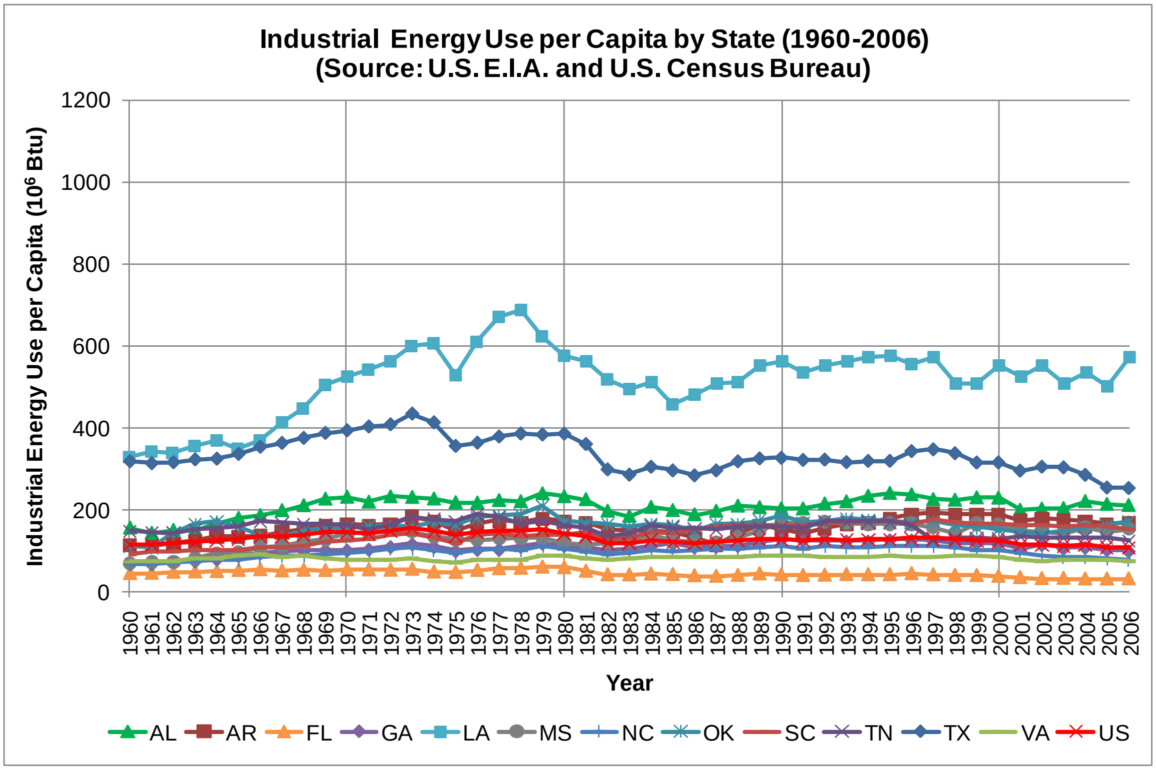


Figure 119: Energy Use per Capita by the Industrial Sector, for the 12 Southern States during 1960-2006

9.8.4 Residential and Commercial Energy Use per Capita for the 12 Southern States during 1960-2006

Figure 120 and Figure 121, respectively, show the residential and the commercial energy use per capita for Texas compared to eleven Southern states during the period of 1960 through 2006. Figure 122 shows the combined residential and commercial per capita energy use that can be regarded as the whole building sector's per capita energy use. The commercial energy use consists of the energy consumed by many different building types, which includes businesses, institutions, and organizations that provide services.

For both residential and commercial, the per capita energy use has been increasing slightly over the years. However, the variation across states was very small compared with other end-use sectors. Per capita energy uses of all twelve states were tightly grouped with a range of about 20 million Btu per capita. In 2006, Alabama ranked the highest while the lowest was Texas. For the commercial sector, Virginia ranked the highest, and the lowest was Mississippi. Virginia ranked the highest of the combined residential and commercial per capita energy use in 2006. Texas was the lowest among the southern 12-states. It is evident that Texas' residential energy use per capita has been decreasing since 2000 while Virginia's commercial energy use per capita has been continuously increasing. In addition, abnormal commercial energy use patterns were found in Louisiana and Tennessee. In the late 1970s, Louisiana's commercial energy use per capita was increasing, while in the mid-1990s, Tennessee's commercial energy use per capita declined suddenly.

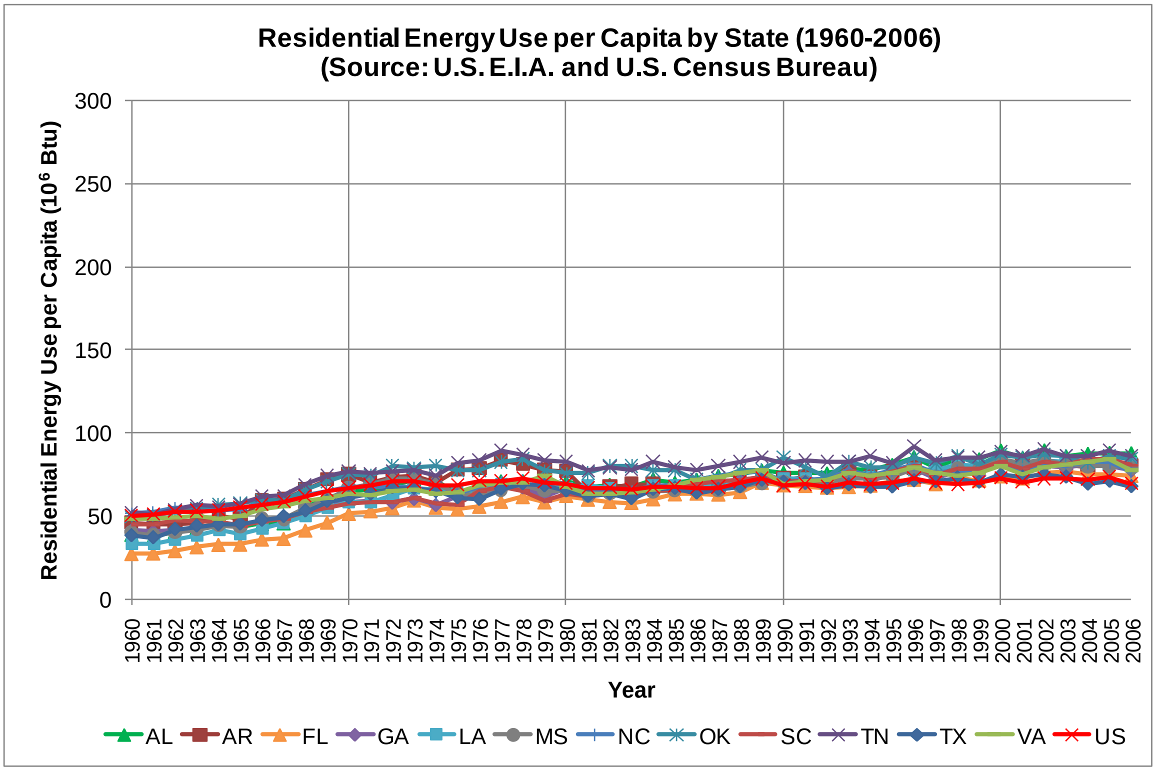


Figure 120: Energy Use per Capita by the Residential Sector, for the 12 Southern States during 1960-2006

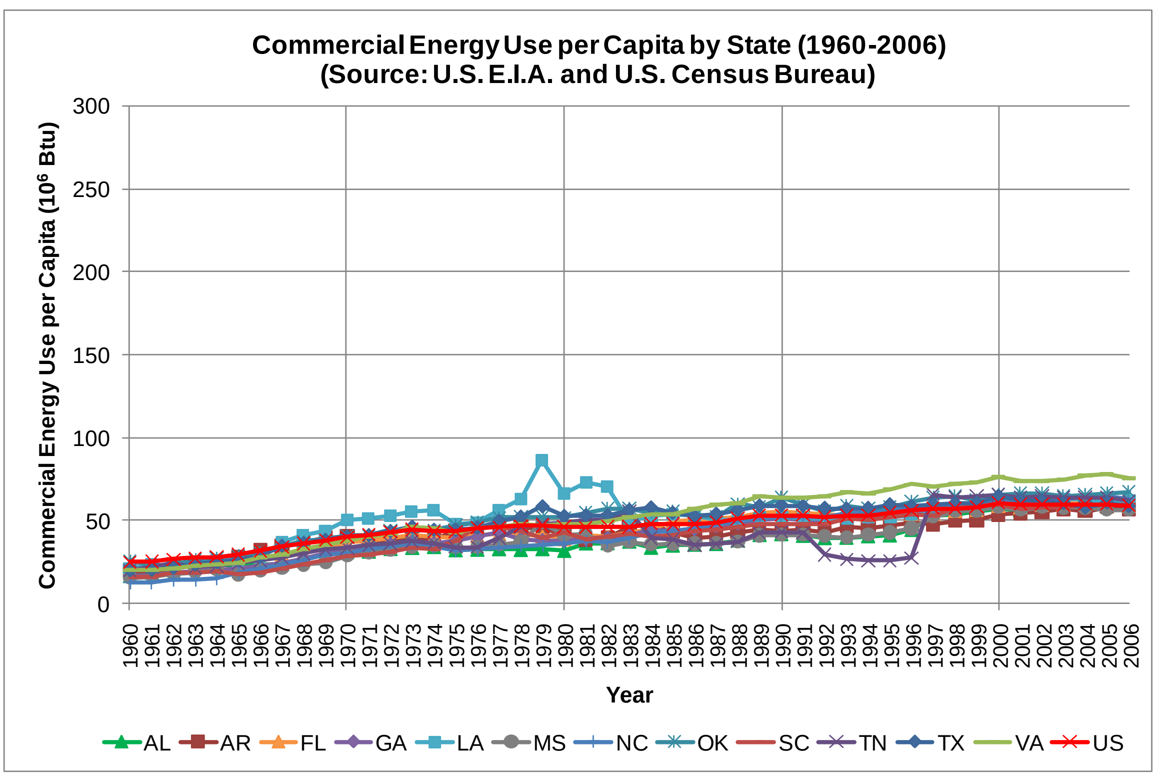


Figure 121: Energy Use per Capita by the Commercial Sector, for the 12 Southern States during 1960-2006

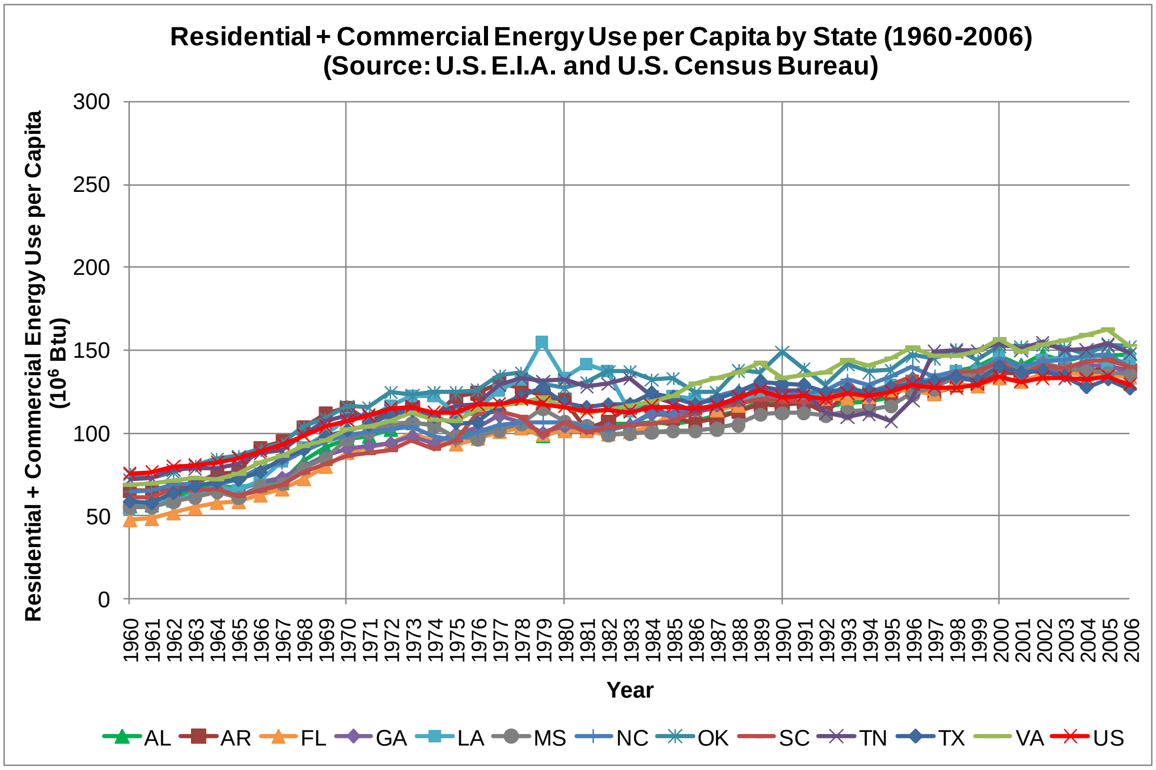


Figure 122: Energy Use per Capita by the Residential and Commercial Sector, for the 12 Southern States during 1960-2006

9.8.5 Transportation Energy Use per Capita for the 12 Southern States during 1960-2006

Figure 123 shows the transportation energy use per capita for Texas compared to eleven Southern states during the period of 1960 through 2006. The historical per capita transportation energy use patterns have remained constant since the mid-1970s, except for Louisiana. Louisiana ranked the highest and showed distinctly high transportation energy intensity. This is mainly because of the river bridge traffic that transports oil and gas. The second highest group consists of Mississippi, Texas, and Oklahoma. It is notable that Texas' transportation energy intensity is constant while the transportation energy uses per capita in Mississippi and Oklahoma continued to rise. The lowest group was Florida and North Carolina.

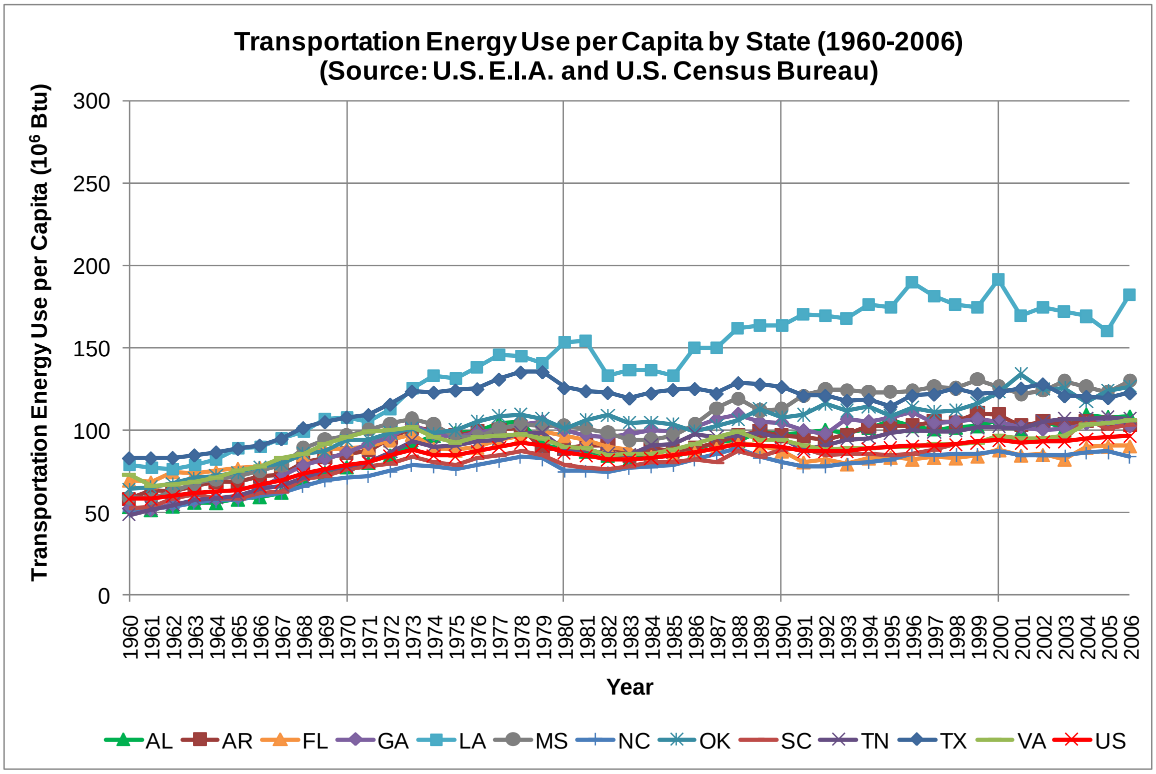


Figure 123: Energy Use per Capita by the Transportation Sector, for the 12 Southern States during 1960-2006

9.8.6 Electric Power Energy Use per Capita for the 12 Southern States during 1960-2006

Figure 124 shows the electric power energy use per capita for Texas compared to eleven Southern states during the period of 1960 through 2006. The electric power energy use consists of the energy consumed by facilities to generate, transmit, and distribute electric energy. Thus, it must be noted that the amount of electricity produced in the state is different than that consumed in the state.

The historical per capita electric power energy use per capita has been rising constantly across all twelve states. Alabama ranked the highest with 296 million Btu per capita in 2006 and showed a distinctly high increase in the rate of electric power energy use. The second highest was South Carolina with 232 million Btu per capita in 2006, and the lowest group consisted of Florida and North Carolina. Although the top two states, Alabama and South Carolina, export surplus energy to other states, they are also big electricity energy consumers. Among the 50 states and the District of Columbia, Alabama and South Carolina ranked in third and fifth place, respectively, in total electricity energy per capita consumed within the state.

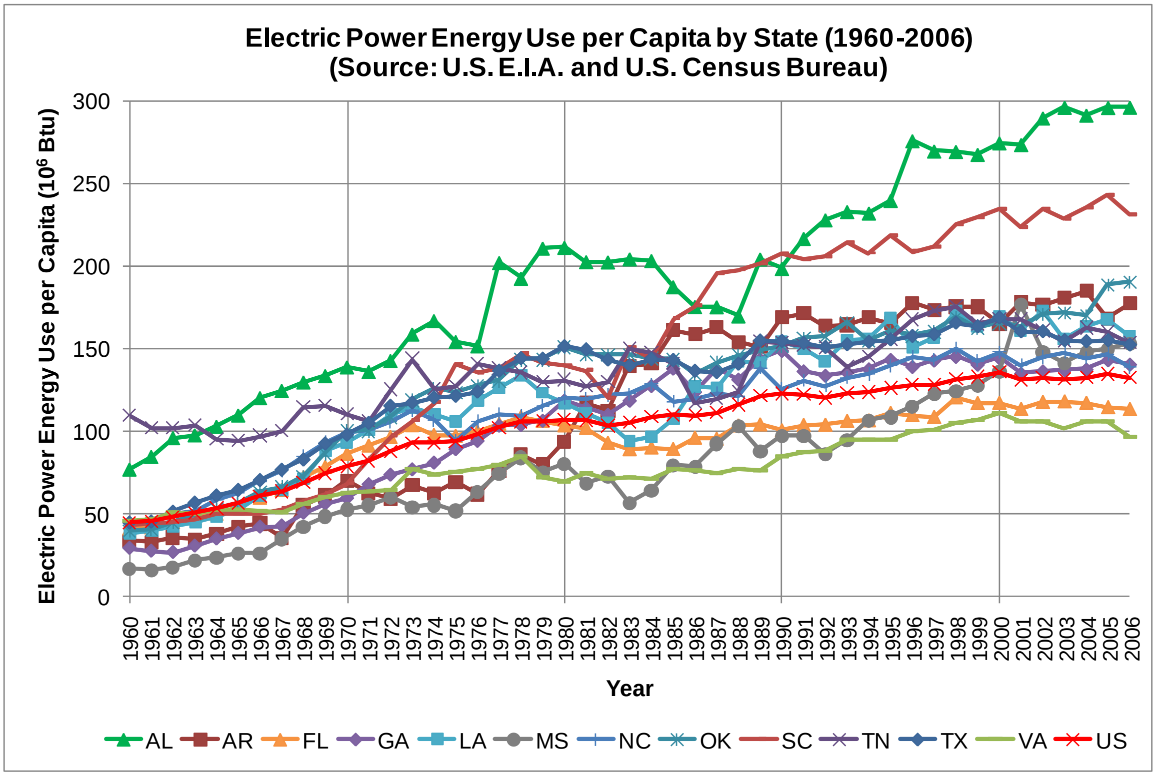


Figure 124: Energy Use per Capita by the Electric Power Sector, for the 12 Southern States during 1960-2006

9.9 Energy Use and Energy Use per Capita by End-Use Sector and Fuel Source During 1960-2006 for U.S. and Texas

9.9.1 Overview

This section covers the historical energy use and energy use per capita by end-use sector and fuel source during 1960-2006 for the U.S. and each of the southern 12-states. This section can be used for a comparison of energy use within the states by end-use and by fuel-source. The end-use sectors consist of residential, commercial, industrial and transportation. The fuel sources consist of coal, natural gas, petroleum and “other.” These other fuel sources include nuclear electric power, hydro-electric power, biomass, geothermal, wind, photovoltaic, solar thermal energy, and net imports of electricity.

In Section 9.9.2, the historical U.S. total energy use, both total and per capita, is displayed by end-use sector and by fuel source. In Section 9.9.3, Texas’ historical energy use, both total and per capita, is displayed by end-use sector and by fuel source. The energy consumption of the electric power sector was also displayed in the chart of end-use sector energy use. On the Texas charts, the U.S. average per capita energy use is also displayed together for the purpose of a comparison. The red dotted line indicates the U.S. average energy use per capita.

For Texas, the scale of 1,000 million Btu was used. Figure 125 presents the total energy use of the SEEC-12 states during the period of 1960 through 2006 to give an idea how they compared. Per capita total energy use of the southern 12 states is displayed in Figure 118.

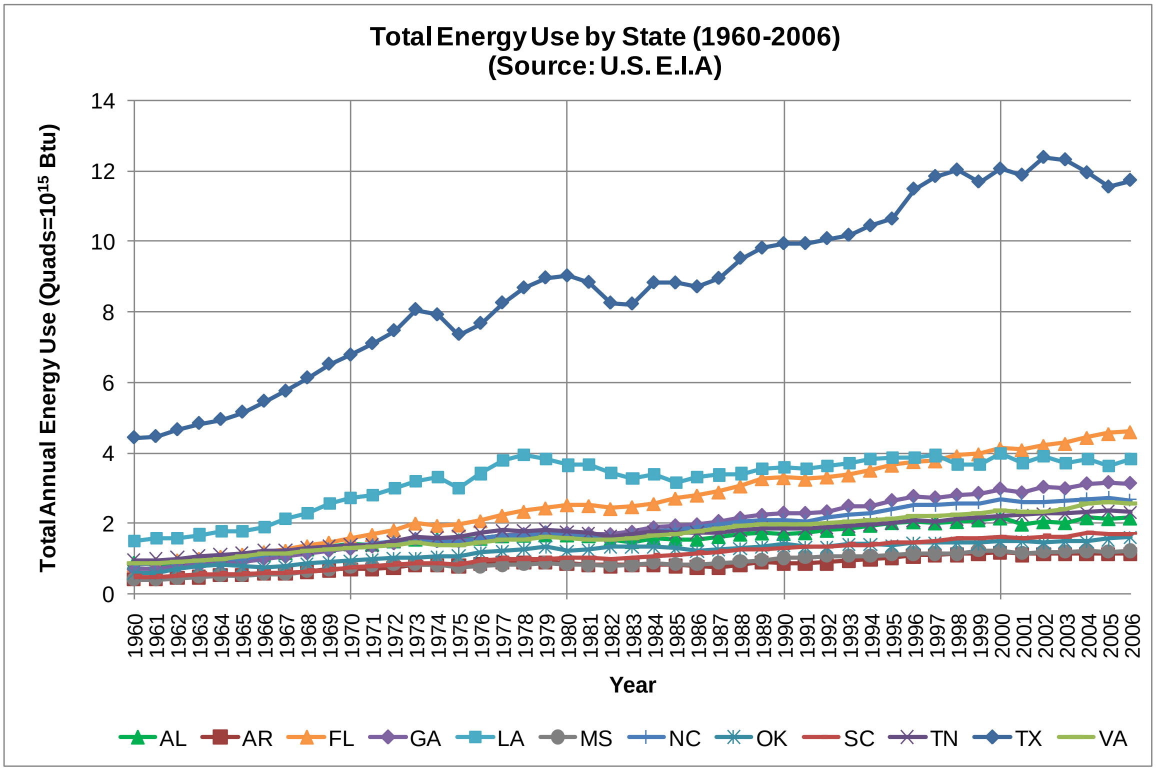


Figure 125: Total Energy Use, for the 12 Southern States during 1960-2006

9.9.2 U.S. Total

Figure 126 and Figure 127, respectively, show the total and per capita energy use of the U.S. by end-use sector (residential, commercial, industrial and transportation) and electric power sector during the period of 1960 through 2006. Figure 128 and Figure 129 show the total and per capita energy use of the U.S. by fuel source during the period of 1960 through 2006. The U.S. total energy use has been continuously rising while the per capita U.S. energy use has remained constant. Since 2000, the electric power sector consumed the largest amount of total energy among end-use sectors, followed by industrial, transportation, residential and commercial. As far as fuel source, the energy consumption of petroleum-based products distinctly occupied the largest proportion of the total. There were little differences between natural gas and coal products while other fuel sources occupied the smallest proportion.

The total population and energy use information for the U.S. in 2006 is as follows:

- U.S. Total Population (2006): 298,362,973
- U.S. Total Energy Use (Quads=10^{15} Btu, 2006): 99.52 Quads

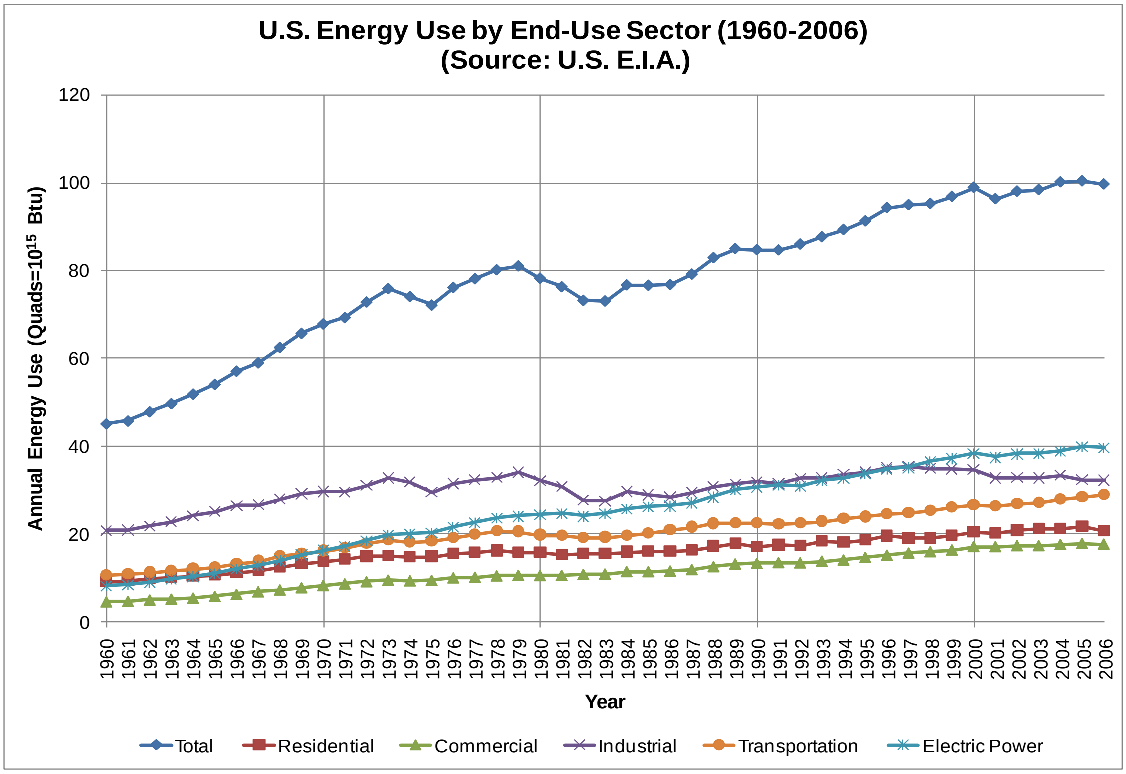


Figure 126: U.S. Total Energy Use by End-Use Sector during 1960-2006

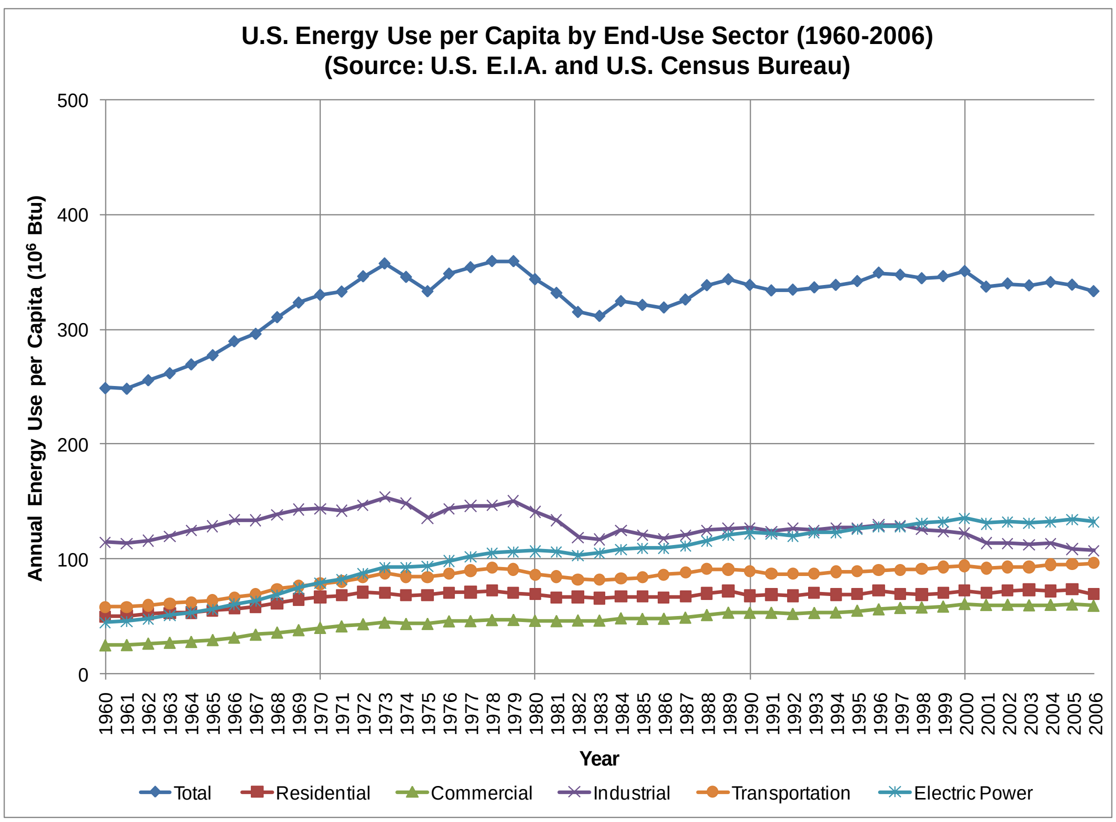


Figure 127: Total Energy Use per Capita by End-Use Sector during 1960-2006

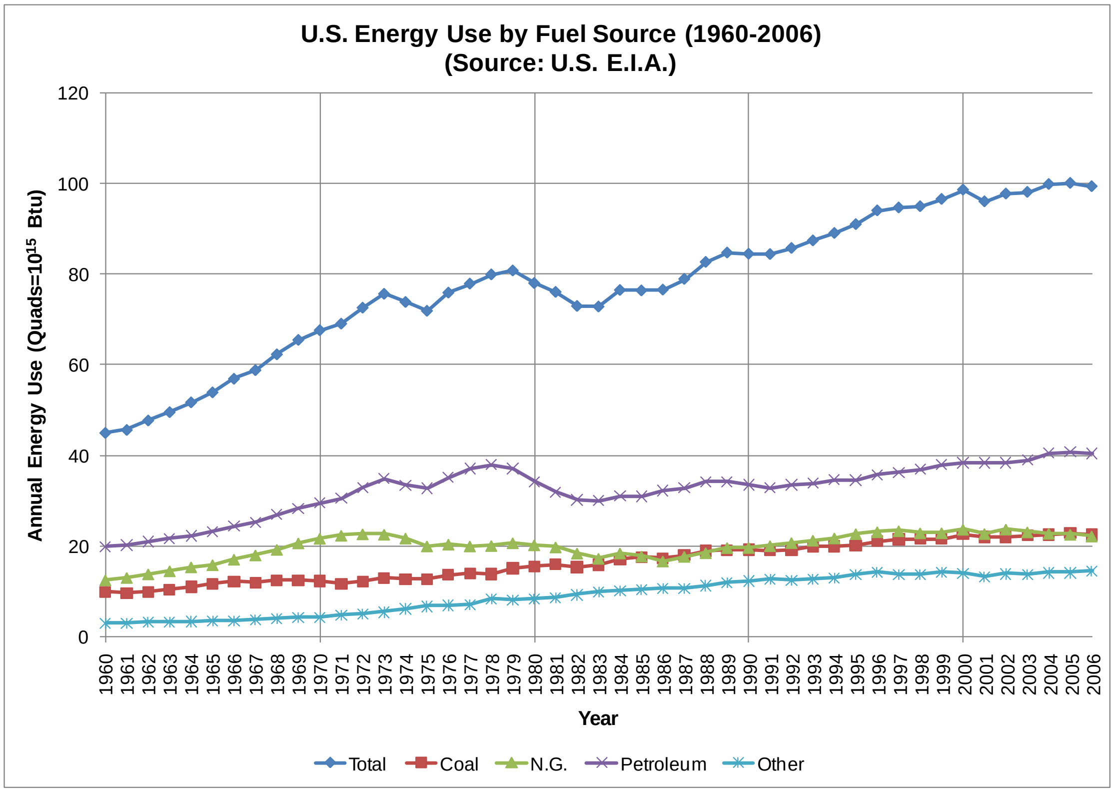


Figure 128: U.S. Total Energy Use by Fuel Source during 1960-2006

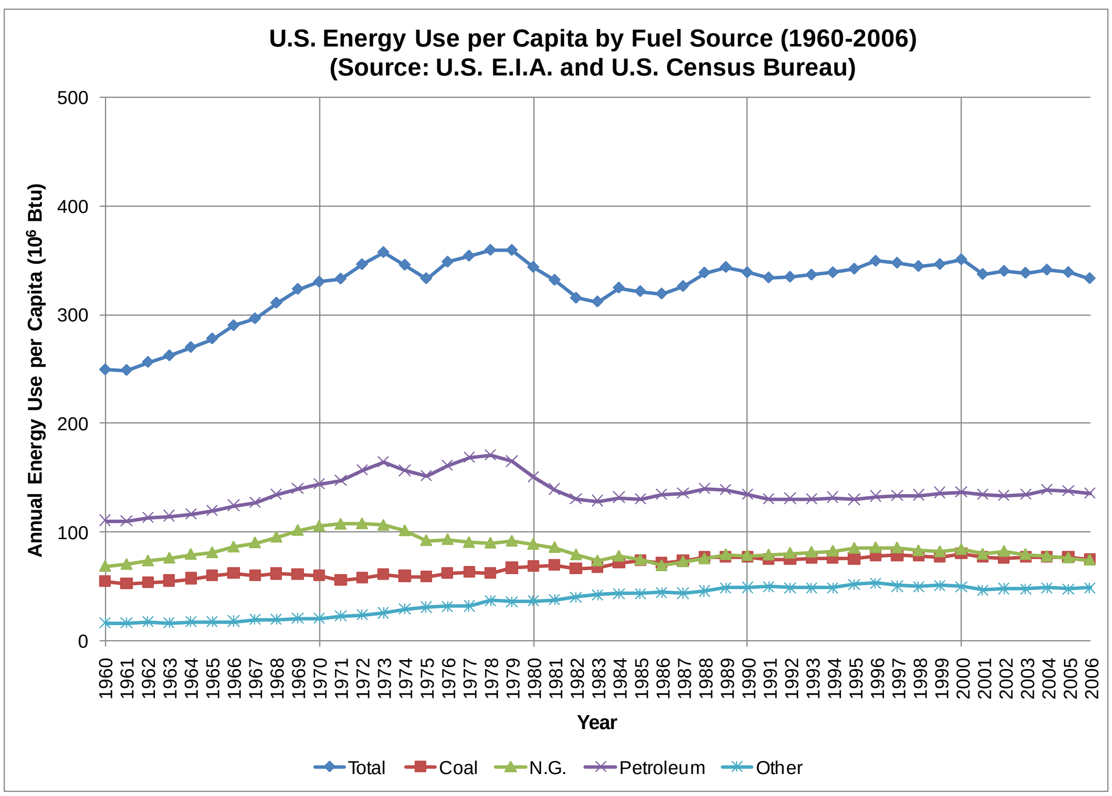


Figure 129: U.S. Total Energy Use per Capita by Fuel Source during 1960-2006

9.9.3 Texas

Figure 130 and Figure 131, respectively, show the total and per capita energy use of Texas by the end-use sector during the period of 1960 through 2006. Figure 132 and Figure 133, respectively, show the total and per capita energy use of Texas by fuel sources during the period of 1960 through 2006. Texas' total energy use has been continuously rising while per capita energy use has remained constant. Since 2000, per capita energy use in Texas has started decreasing. Texas' energy use per capita is still far beyond the U.S. average per capita. The industrial sector consumed the largest amount of total energy among end-use sectors. The industrial sector was followed by electric power, transportation, residential and commercial. As far as fuel source, the energy consumption of petroleum-based products occupied the largest proportion of total, followed by natural gas, coal, and other fuel sources. It is evident that the energy consumption of natural gas products has suddenly decreased since 2004.

The total population and energy use information for Texas in 2006 is as follows:

- Texas Total Population (2006): 23,367,534
- Texas Total Energy Use (Quads=10^{15} Btu, 2006): 11.74 Quads

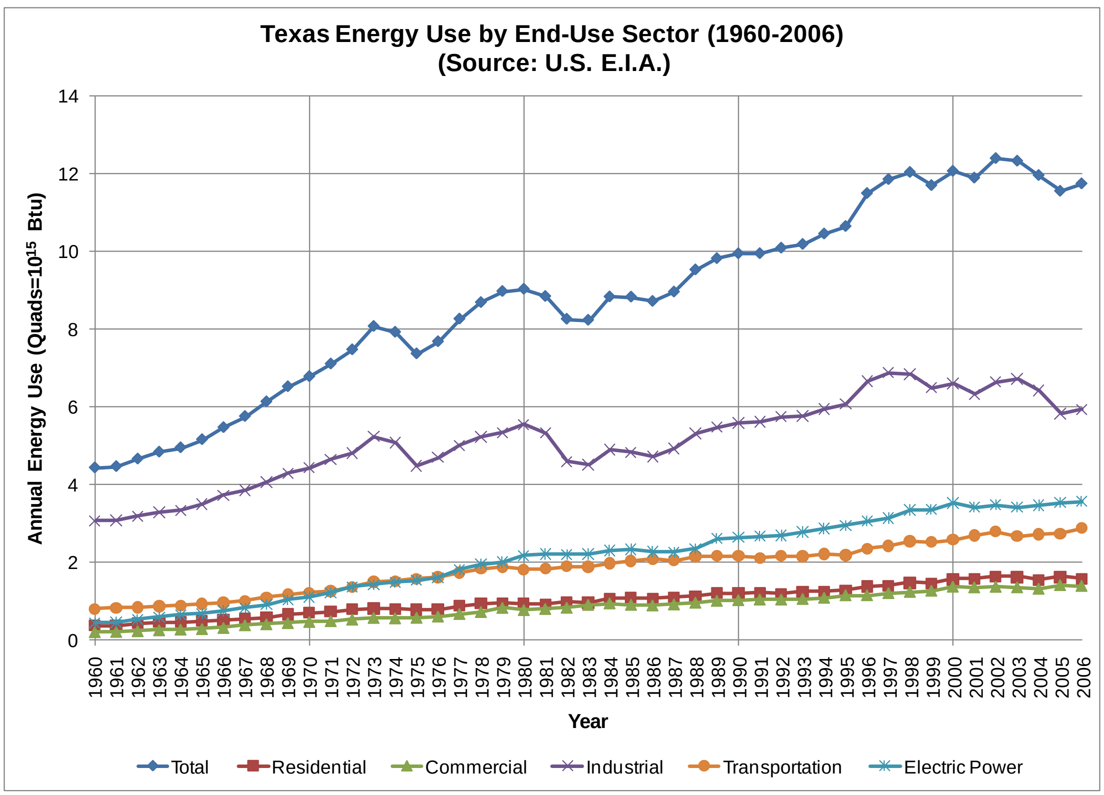


Figure 130: Texas Energy Use by End-Use Sector during 1960-2006

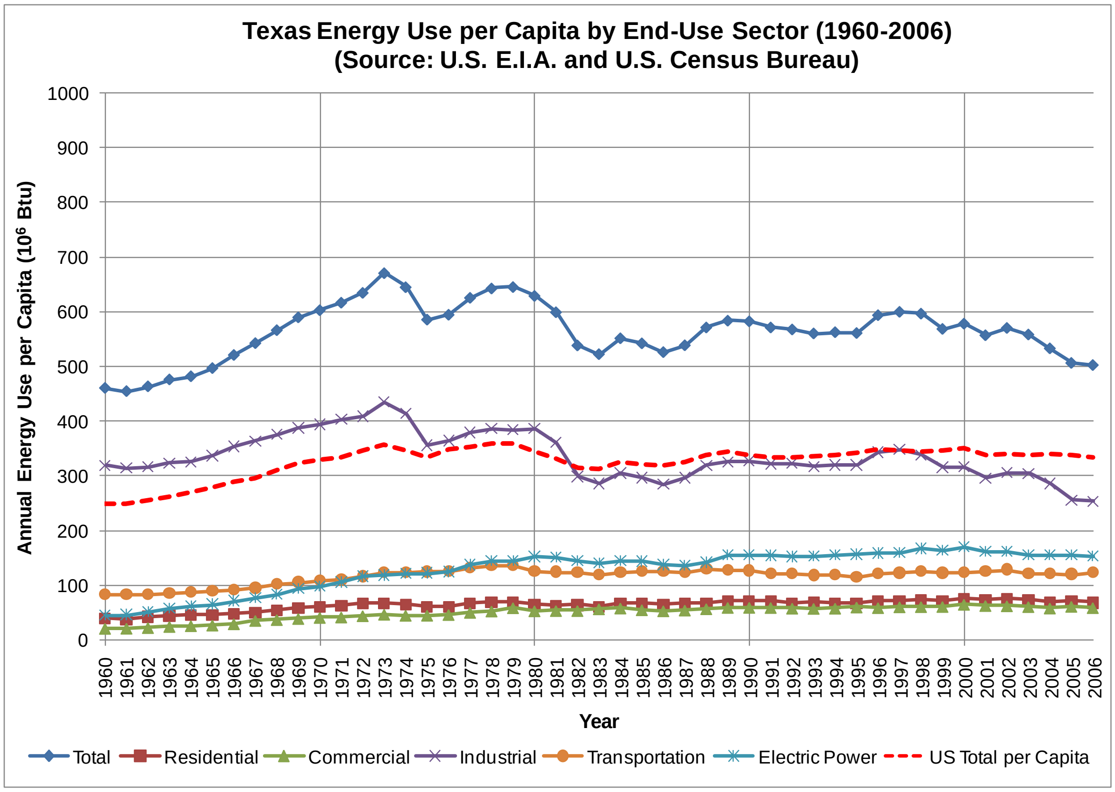


Figure 131: Texas Energy Use per Capita by End-Use Sector during 1960-2006

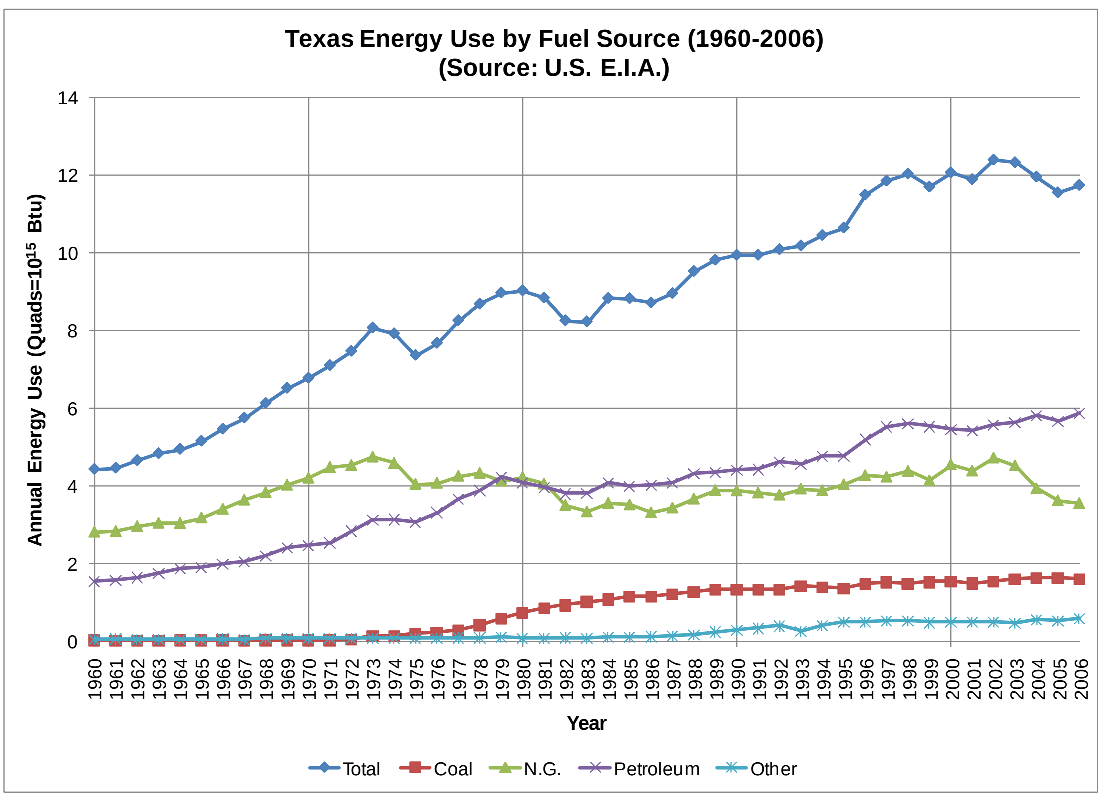


Figure 132: Texas Energy Use by Fuel Source during 1960-2006

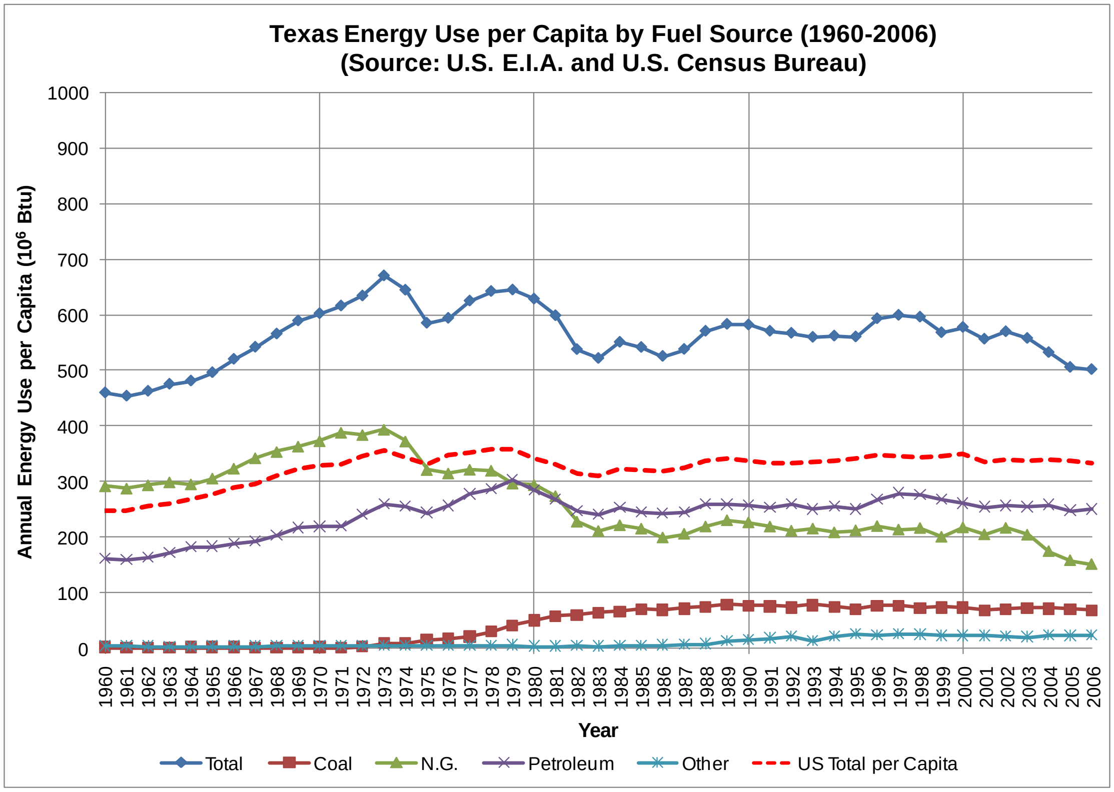


Figure 133: Texas Energy Use per Capita by Fuel Source during 1960-2006

10 Planned Verification of the Calculators: eCALC, IC3 and AIM

As part of the analysis effort, verification and validation efforts are planned for each of the major analysis areas in the emissions calculator, including: on-site inspections and calibrated simulations.

10.1 On-site Inspections

On-site inspection work continued in 2009, including residential and commercial buildings to determine if specific energy-conserving features are being installed properly.

10.2 Calibrated Simulations

Calibrated simulations have been completed for two commercial sites and one residential site to help confirm the accuracy of the code-compliant DOE-2 simulations. For each site, existing data loggers, installed from previous projects were restarted and the data from the sensors checked for accuracy. These sites include a standard office building and a K-12 school in College Station, Texas.

10.2.1 Standard Office building

The calibrated simulation of a standard office building using the Texas A&M University Systems Building in College Station, Texas, continues. Figure 134 to Figure 141 show the related information from this site. This building is currently being monitored as part of the campus energy conservation program. The goal with this site is to develop a calibrated simulation of the actual building (Figure 136), and a representative building (Figure 137), and then compare/contrast the savings differences between the calibrated model vs the representative model.

In May of 2008, a thesis entitled, "Methodology to Develop and Test an Easy-To-Use Procedure for the Preliminary Selection of High-Performance Systems for Office Buildings in Hot and Humid Climates" developed a procedure using the John Connally Building in College Station, Texas.

Figure 134: Standard Office Building (Texas A&M University Systems Building, College Station, Texas)

Figure 135: Standard Office Building (Texas A&M University Systems Building, College Station, Texas)

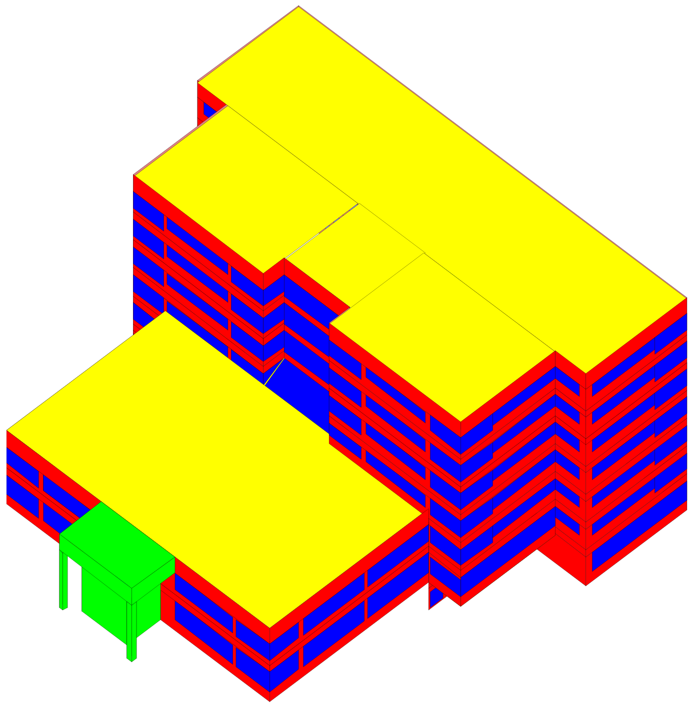


Figure 136: Computer Simulation (DOE-2.1E) of Case Study Office Building

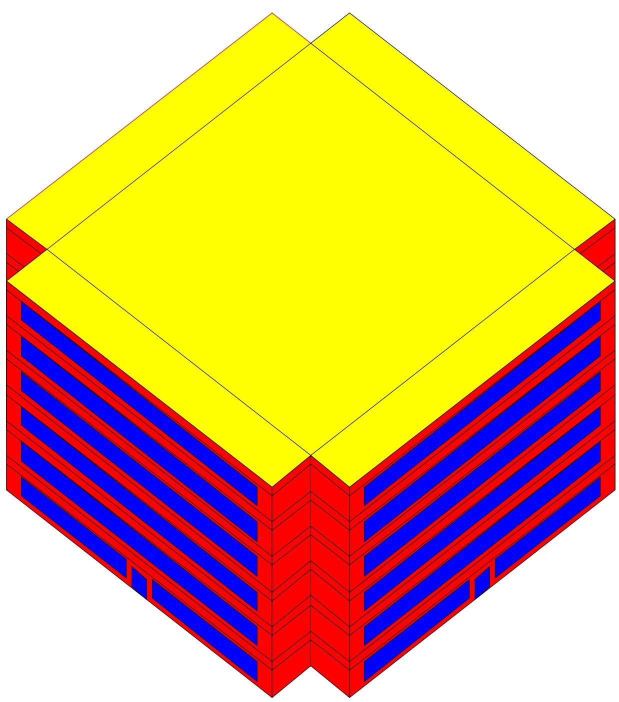


Figure 137: Computer Simulation (DOE-2.1E) of Base Case Office Building

Figure 138: Air Handling Unit in the 5th Floor of the John Connally Building

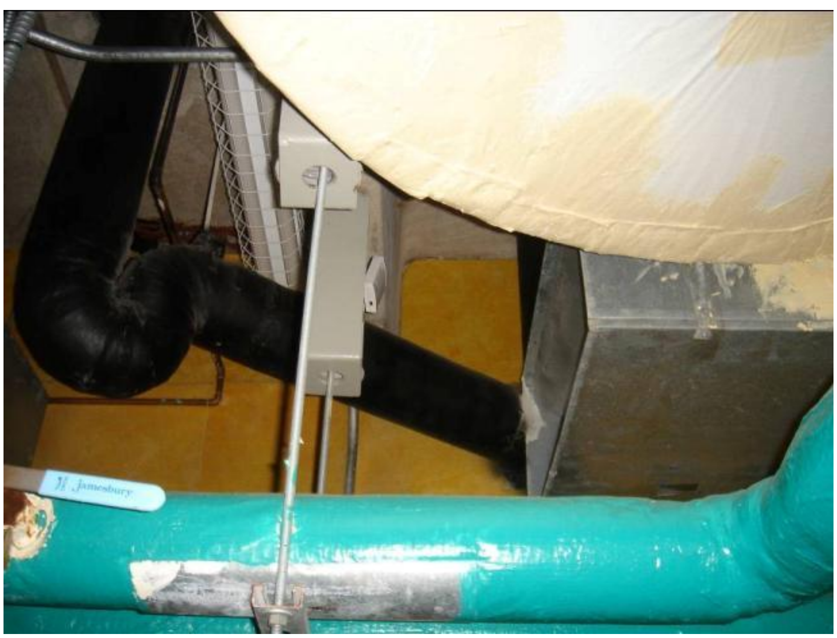


Figure 139: Installation of a Portable Logger to Measure the Return Air Temperature of an AHU on the 5th Floor

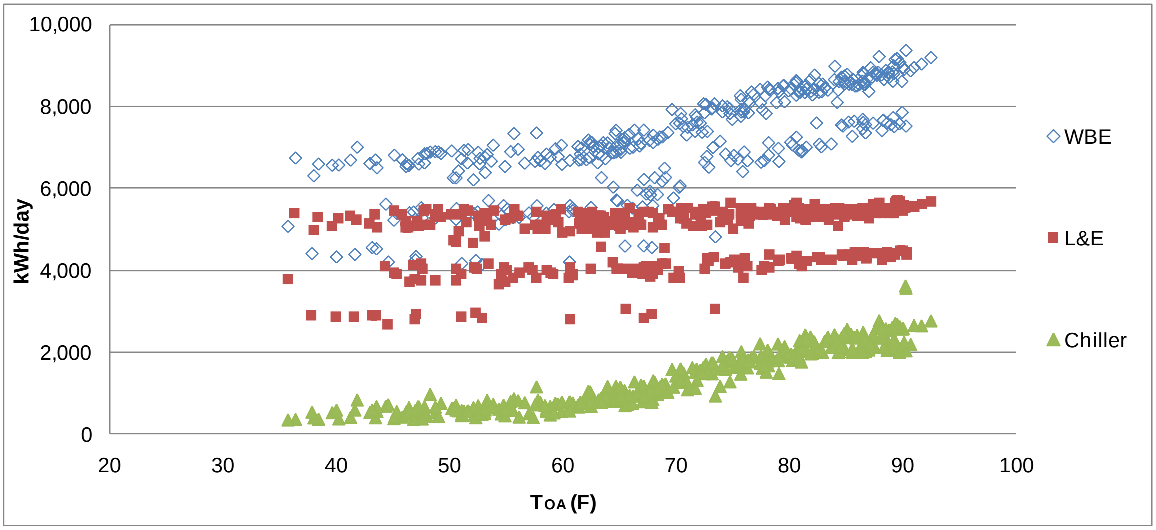
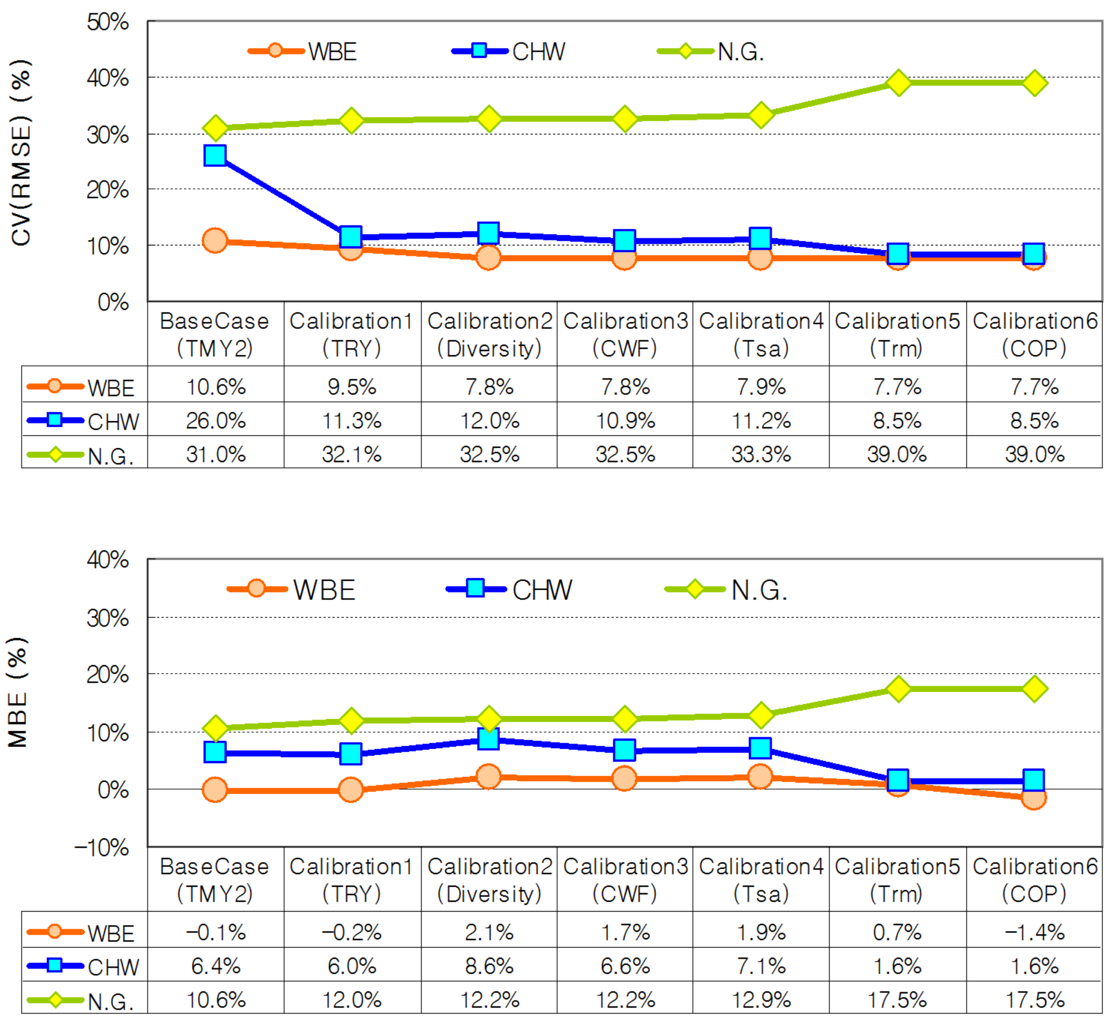


Figure 140: 2009 Scatter Plots from the Data logger Installed in the Case Study Office Building



	BaseCase (TMY2)	Calibration1 (TRY)	Calibration2 (Diversity)	Calibration3 (CWF)	Calibration4 (Tsa)	Calibration5 (Trm)	Calibration6 (COP)
WBE	10.6%	9.5%	7.8%	7.8%	7.9%	7.7%	7.7%
CHW	26.0%	11.3%	12.0%	10.9%	11.2%	8.5%	8.5%
N.G.	31.0%	32.1%	32.5%	32.5%	33.3%	39.0%	39.0%

	BaseCase (TMY2)	Calibration1 (TRY)	Calibration2 (Diversity)	Calibration3 (CWF)	Calibration4 (Tsa)	Calibration5 (Trm)	Calibration6 (COP)
WBE	-0.1%	-0.2%	2.1%	1.7%	1.9%	0.7%	-1.4%
CHW	6.4%	6.0%	8.6%	6.6%	7.1%	1.6%	1.6%
N.G.	10.6%	12.0%	12.2%	12.2%	12.9%	17.5%	17.5%

Figure 141: Goodness of fit indicators for measured versus simulated data from office building

10.2.2 K-12 Elementary School

To expand the capabilities of the emissions calculator, which currently covers office and retail type buildings, K-12 schools were identified as the next largest category of buildings that needed to be included in the emissions reductions calculations. To begin to prepare for this new model, in cooperation with the College Station Independent School District (CSISD), the Laboratory collected representative characteristic shaping data for the school (Figure 142) and then developed a calibrated simulation of the school (Figure 143). Next, a representative shaping model was developed that could be used for an automated school generation (Figure 144 and Figure 145). Finally, actual measured data were gathered from the school to allow for the calibration of the simulation and comparison against the representative model shown in Figure 146, Figure 147, and Figure 148.

In December of 2009, a thesis entitled, “Methodology for the Preliminary Design of High Performance Schools in Hot and Humid Climates” developed an easy-to-use toolkit for the preliminary design of high performance schools in hot and humid climates. The toolkit will allow decision makers, without simulation knowledge to easily evaluate accurately, energy efficient measures for K-12 schools, which contributes to the accelerated dissemination of energy efficient design.

Figure 142: Photo of Case Study Elementary School

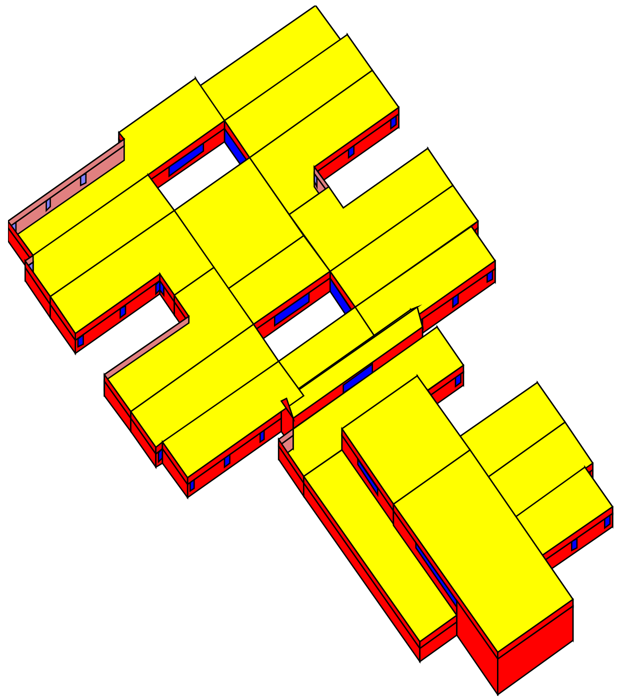


Figure 143: Computer Simulation (DOE-2.1E) of Case Study Elementary School

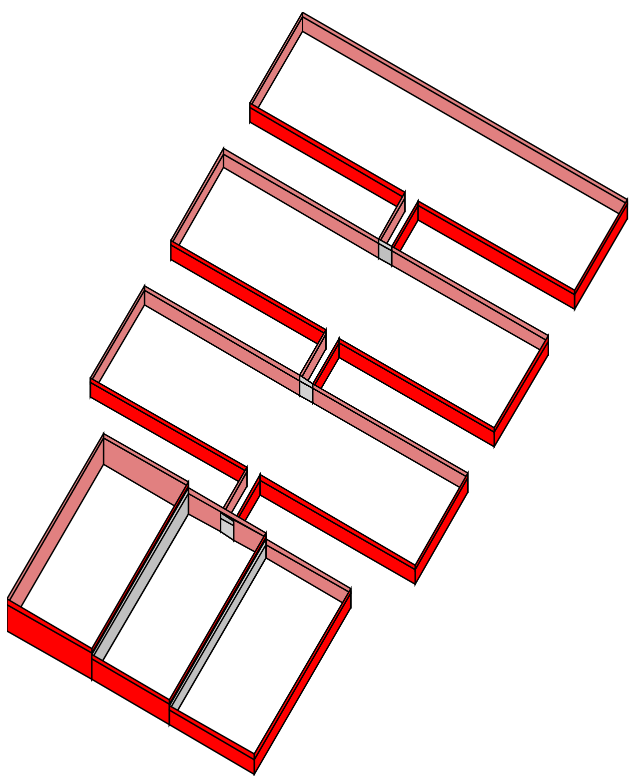


Figure 144: Computer Simulation (DOE-2.1E) of Base Case School Building

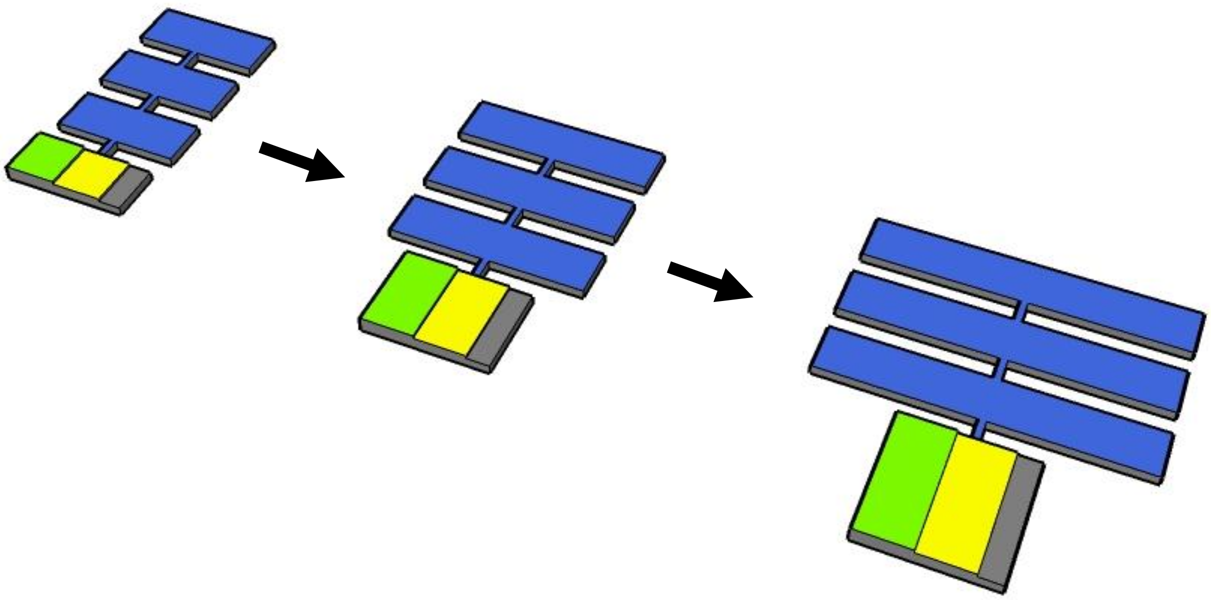


Figure 145: Concept of Base Case School Building

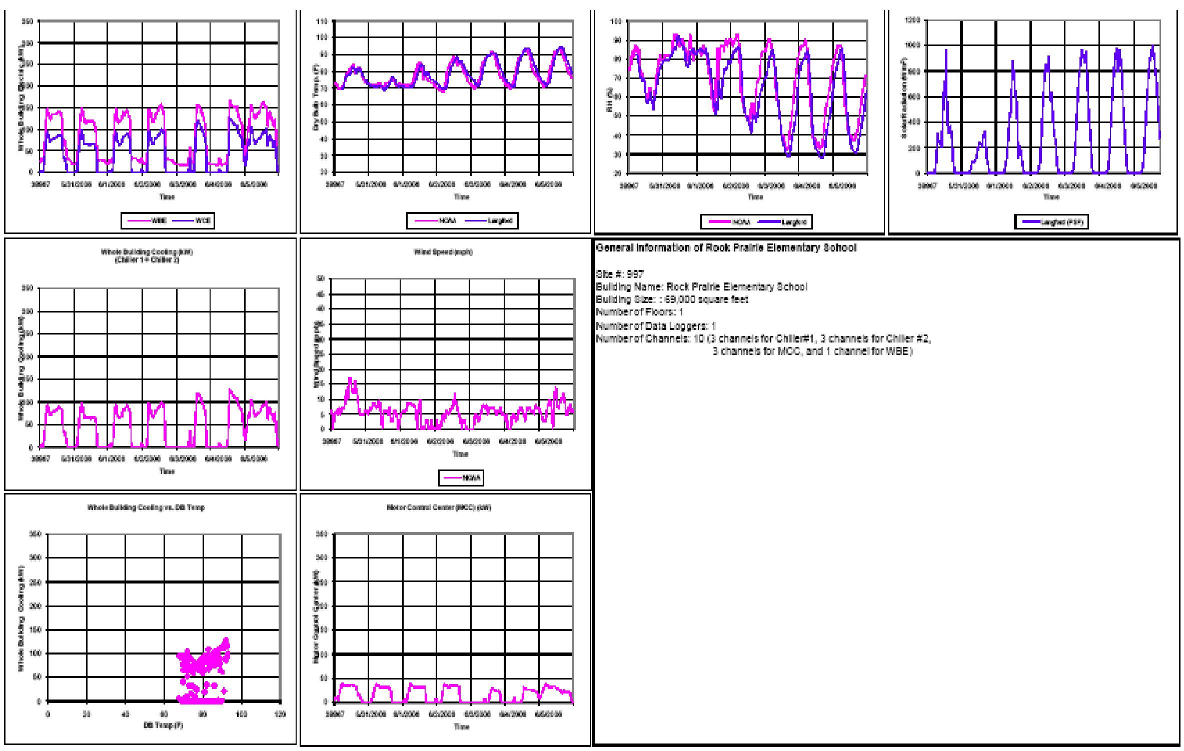


Figure 146: Inspection plots for elementary school

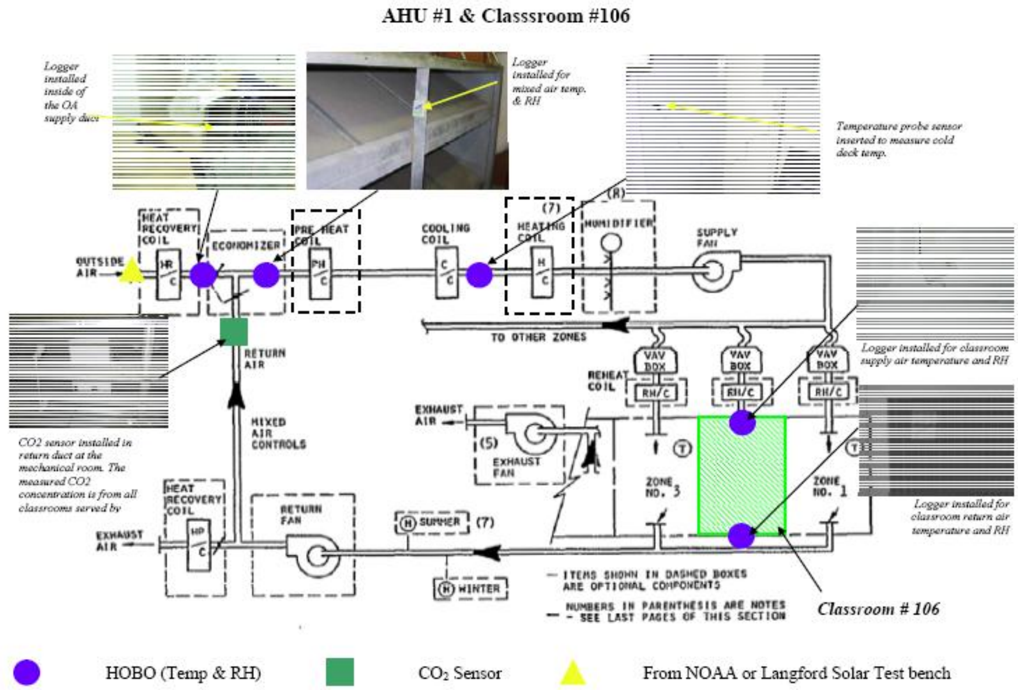


Figure 147: Detailed monitoring diagram for K-12 school

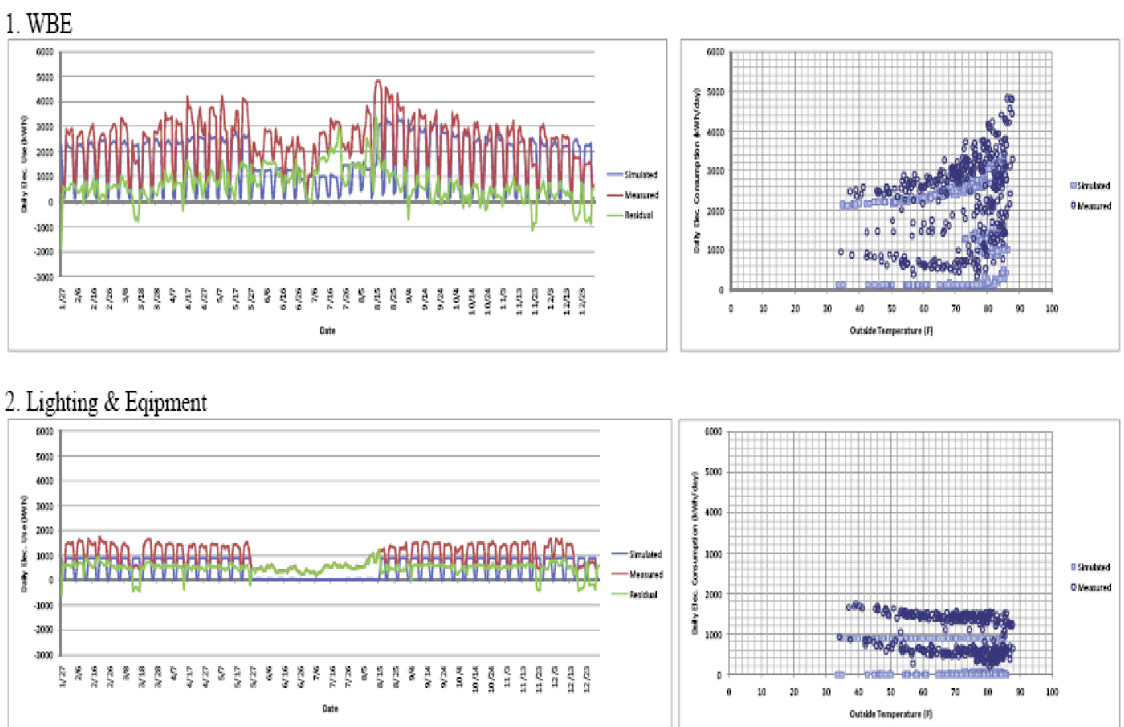


Figure 148: Analysis of data from K-12 school

10.2.3 Solar Test Bench

In 2009 the Laboratory continued with the monitoring of the data from the Solar Test Bench to accommodate the testing of energy-efficient glazing for purposes of verifying the calibrated simulations. Figure 149 shows photos of the instrumentation at the test bench. Figure 150 and Figure 151 show weekly inspection plots from the solar test bench.

Figure 149: Photos of the Laboratory's Solar Test Bench

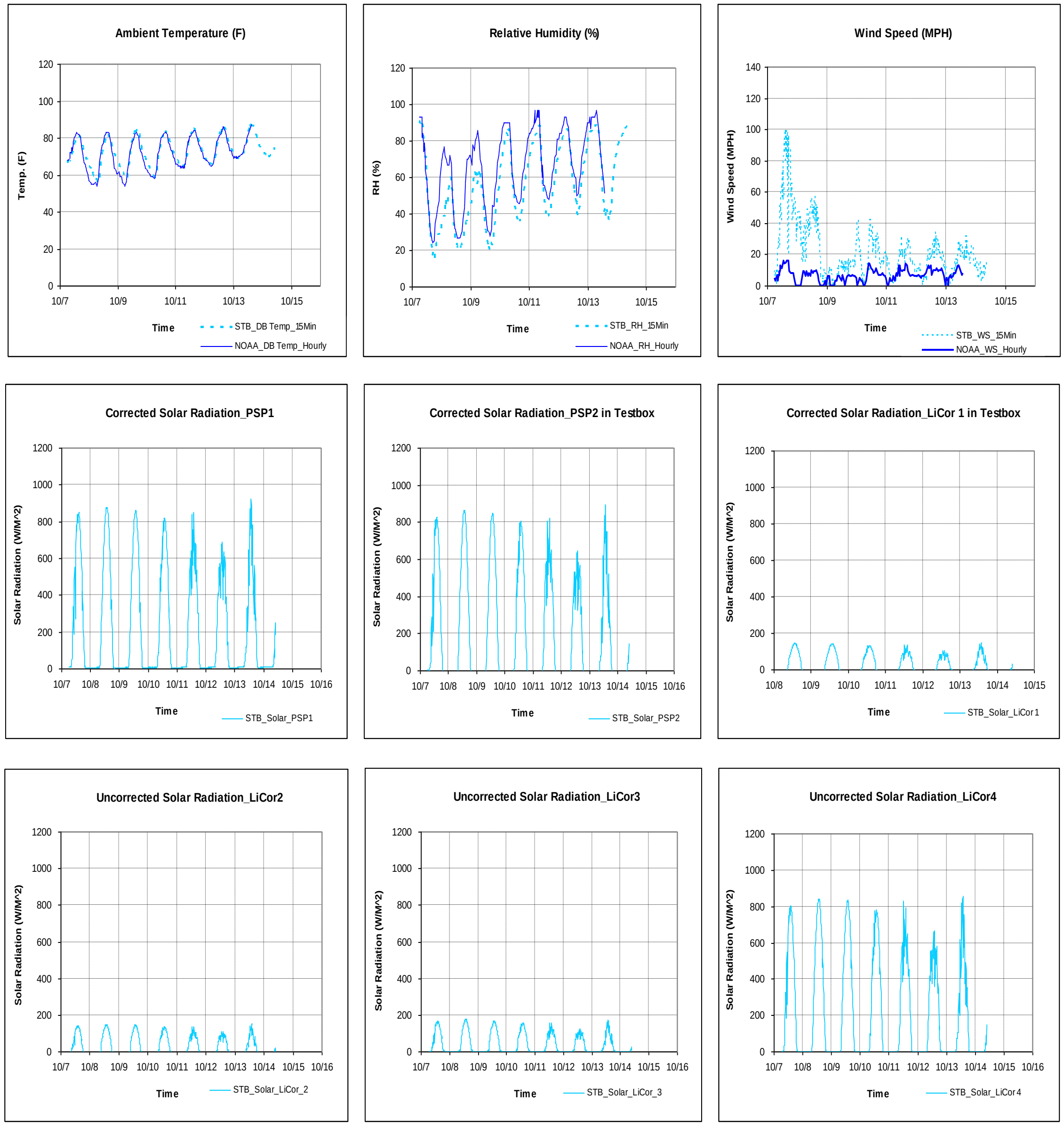


Figure 150: 2009 Weekly Inspection Plots from the Laboratory's Solar Test Bench

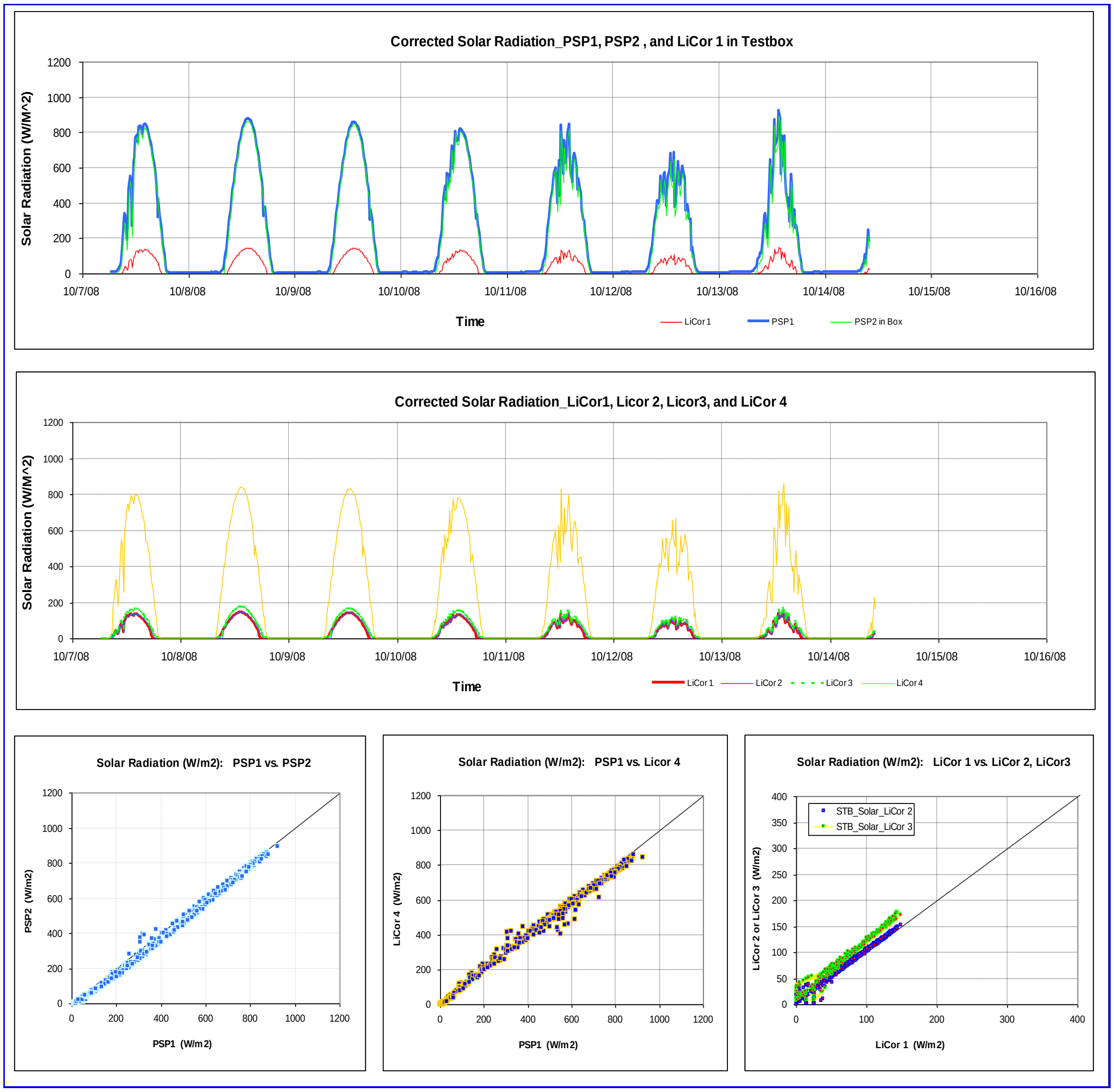


Figure 151: 2009 Weekly Inspection Plots from the Laboratory’s Solar Test Bench

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